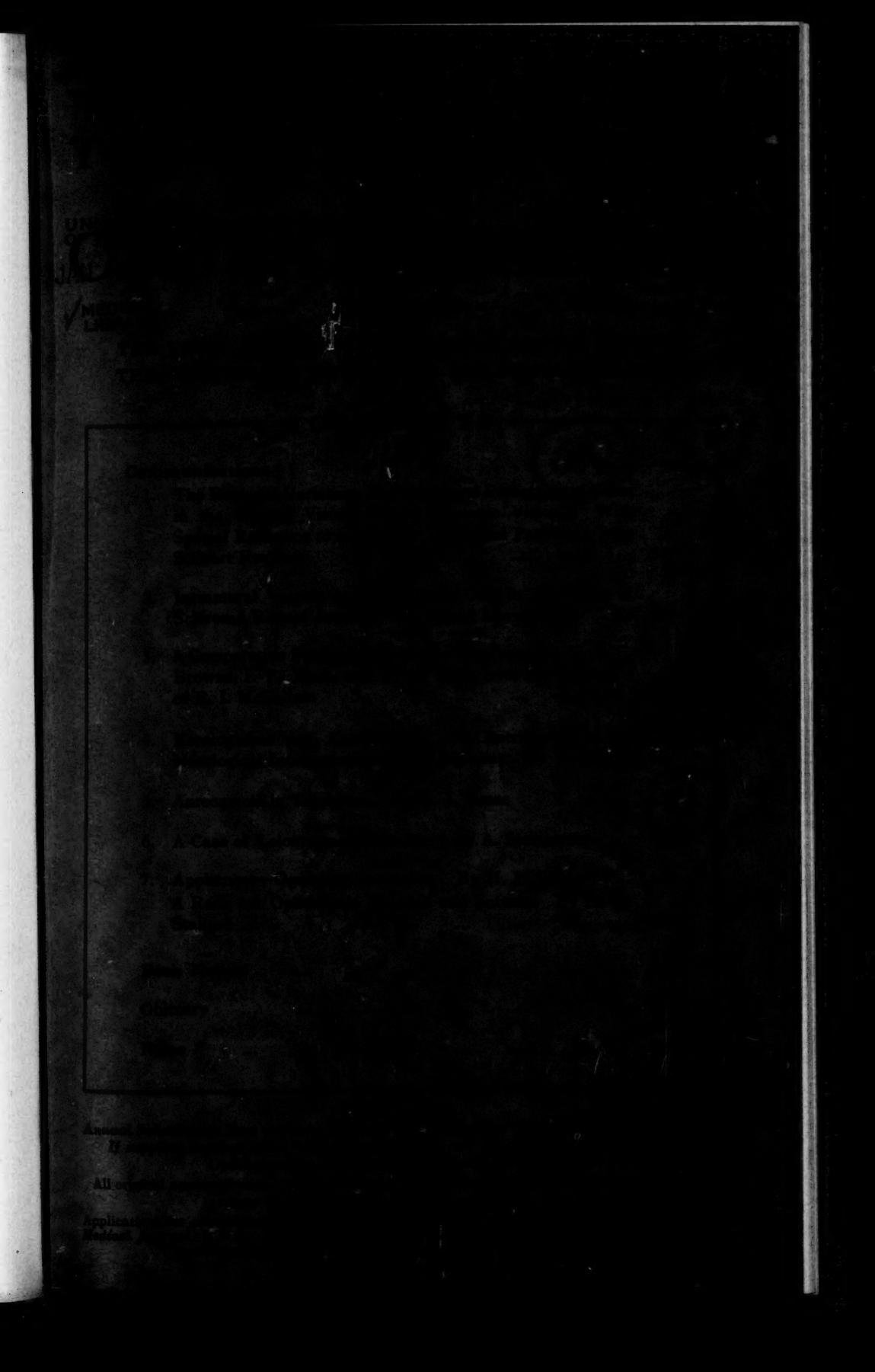

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COMMUNICATIONS

THE REGIONAL VARIATIONS OF EXTRAFOVEAL PERCEPTION OF FORM IN THE CENTRAL VISUAL FIELDS (PHOTOPIC VISION)*

WITH SPECIAL REFERENCE TO LESIONS OF THE VISUAL PATHWAYS

BY

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Introduction

Visual perception of form has, in the past, gained considerable attention from experimental physiologists and psychologists, the former investigating retinal and neural mechanisms, and the latter exploring the complexities of central perceptual processes. In the present investigation the problem of extrafoveal perception of form has been approached from the clinical point of view. An attempt has been made to evolve a clinical method of examining this aspect of visual function and in doing so the

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investigation has been directed mainly towards establishing the accuracy of the test and its value in clinical practice.

The factors influencing the perception of form have been summarized by Duke-Elder (1938) as follows:

(1) State of adaptation of the eye.
(2) Size of the pupil.
(3) Region of the retina stimulated.
(4) Influence of irradiation.
(5) Intensity of illumination.
(6) Spectral nature of light.
(7) Distribution of light.
(8) Condition of illumination of the surrounding field.

The present investigation is concerned only with the regional variations of extrafoveal form perception with the eye in a state of light adaptation while the other factors are kept as constant as possible. The term " perception of form " may be given two meanings. It may be defined as the perception of the form of the visual field or as the perception of the shape of the object-stimulus. The latter definition is the one which will be used here.

Wertheim (1894) is generally credited with the first investigation of extrafoveal form perception although he himself pays tribute to previous workers in this field. From his studies of the regional variations of form perception he constructed a graph which is still reproduced in modern text-books on visual function. Wertheim clearly recognized the variations in extrafoveal perception which exist between individuals, the variations in results which may be produced by different methods of testing form perception, and the influence on the results of practice in the tests by the subject. Rivers (1900), summarizing the information which had then accumulated, stated that acuity is most intense in direct vision and drops rapidly at first and then more slowly towards the periphery, and also that the difference between central and peripheral vision in respect of visual acuity is far greater than for other kinds of retinal sensibility. He attributed to Dobrowolsky and Gaine (1876) the discovery that the low degree of acuity at the periphery can be greatly improved by practice, thus differing in this respect from the sensibility for light and colour. Evans (1929) and Ludvigh (1941) both measured extrafoveal form perception, as did Wertheim's predecessors, by using Snellen type. This, however, does not allow vision to be examined beyond 10° of the fixation point and the method is therefore of limited value. Akelaitis (1942), in studying the effects of section of the corpus callosum, measured extrafoveal form perception with the shapes used in the Stanford-Binet intelligence test and also with common objects such as a pipe, comb, pencil, and pair of scissors. He described three cases in

which there was impairment of form perception although the fields of light perception were full. Low (1943) made the first adequate investigation of the problem of the regional variations of form perception by using a method employing Landolt's broken circles. From a study of a hundred normal subjects he concluded that extrafoveal perception of form is extremely variable between one subject and another, that it is not closely related to macular vision, and that it is a function capable of training. He noted, too, that beyond 30° of the fixation point the lens ceases to act efficiently.

This review of the literature shows that little work has been done on the regional variations of form perception in the presence of lesions of the visual pathways. This has probably been due to the difficulty that has been found in establishing the range of normality and of devising a test suited to the mental status of the average hospital patient. Because of their complexity, the methods of Low and of others investigating the general problem of form perception demand a type of co-operation rarely to be expected from a patient suffering from intracranial disease. Moreover it is a little difficult to correlate the results of such methods with the findings of clinical perimetry, a condition which it is necessary to fulfil in a study of lesions of the visual pathways.

In the present investigation a method was evolved which allows the results to be charted in a manner comparable to the visual field chart used in clinical perimetry. The investigation was further simplified by limiting the study to the central visual fields (30°) where the limits of normality are more easily defined than in the peripheral fields. Finally the value of the method was assessed by correlating the results with other clinical, radiological, and pathological studies of the patients chosen for investigation.

Apparatus

Five test-targets were used. Each consisted of a black card 2½ inches square supported by a black wire about 1 foot long (Fig. 1). On one side of each card a square was constructed with strips of white paper ⅛ inch wide, except in the case of the smallest square in which the strips were $\frac{1}{16}$ inch wide. The sizes of the squares (2, 1¼, ¾, ½ and ¼ inches respectively) were determined by trial and error. The final choice was such that in a subject with good vision the squares could be identified at 5° intervals from the centre of the screen. Since examination beyond 25° was not attempted five targets were sufficient to cover all points on the screen.

On the reverse side of each card four strips of white paper were fixed in an irregular fashion to form what will henceforth be called a "jumble". The total area of white paper used for each jumble was equal to that used for the square on the obverse side of the card, and the four strips of the jumble were distributed over an area approximately equal to that covered by the square.

Procedure

The examination of the visual fields was made in a dark room on a 2-metre Bjerrum screen illuminated by two electric lamps. The patient, who always entered the room from daylight or from a fully lighted room, was seated at a distance of 2 metres from the screen with his head supported in a chin rest so that his eyes were at the same level as the centre of the screen.

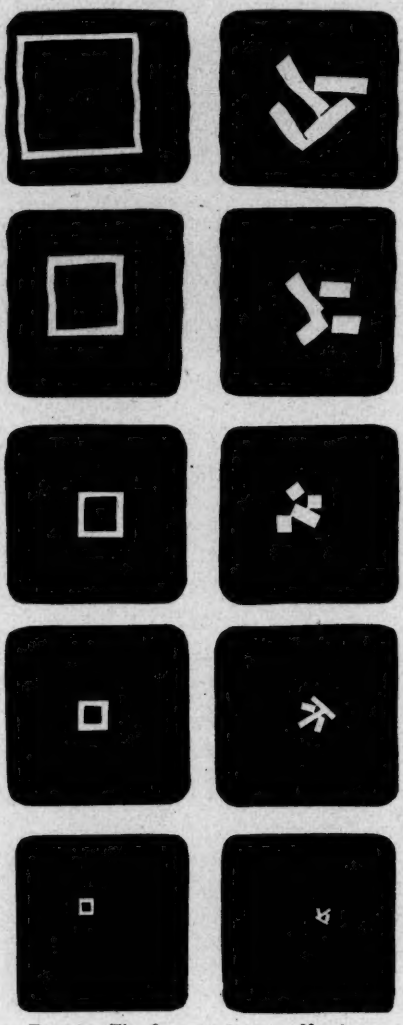


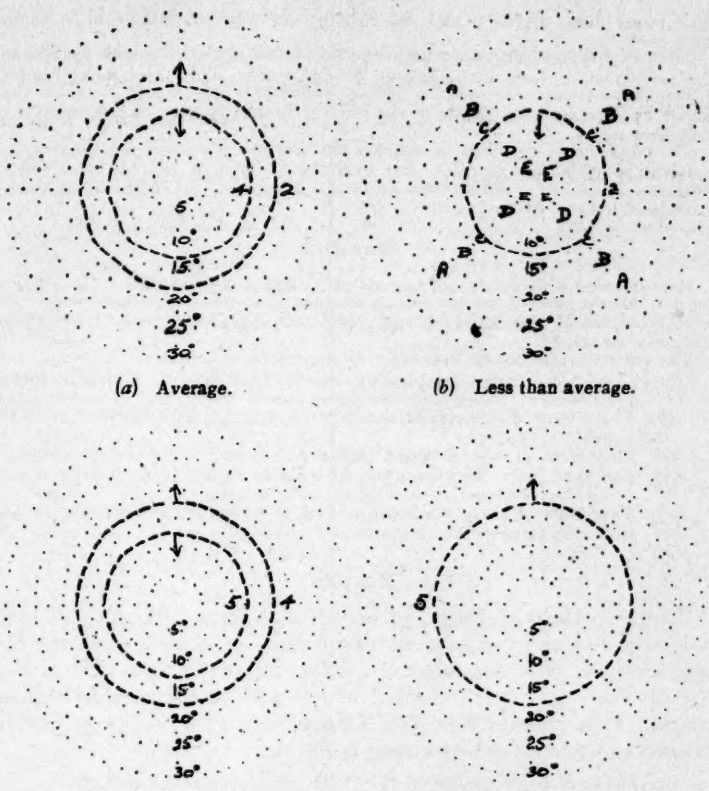
FIG. 1.—The five test-targets, No. 1 at the top ($\times\frac{2}{3}$).

The fields of light and colour perception of the right eye were first plotted on the screen, unless vision in that eye was much less than in the left. Extrafoveal perception of form was then examined in the same eye. The left eye was treated in a similar way and finally the peripheral fields were charted on a perimeter. The resting eye was covered by an eye-shade. Macular vision was measured with Snellen and Jaeger type.

In testing the perception of form, the two sides of Target 1 were first demonstrated to the patient, who was then told that, while keeping his eye fixed on the centre of the screen, he was to name the side of the target being presented to him at various points on the screen. He was asked to state his first impression of the target and not to wait and think about it. If he found it difficult to make up his mind in a moment or so, he was to state simply that he did not know which side of the target was being shown to him.

The targets were held against the screen at a series of points lying on the radii 45°, 135°, 225° and 315° from the vertical. These points, A, B, C, D and E (Chart A, Fig. 2), were spaced at 5° intervals, A being midway between the marks on the screen indicating 20° and 25°.

Beginning with Target 1, the five targets were used in descending order of size. Each was used in turn, being first held at the point where the previous target had been correctly identified, and then moved in towards the centre until correct answers were given. Each was used in all quadrants before passing on to the next target. No fixed rules governed the number of times the target was shown at each point or the sequence of squares and jumbles. Generally the patient recognized the square or was unable to express an opinion, so that it was sufficient to show the



(*a*) Average. (*b*) Less than average.

(*c*) Slightly better than average. (*d*) Much better than average.

FIG. 2.—Chart A, showing standard tests.

square once or twice at each point, the jumble being reserved for occasional checks on his answers. A jumble was rarely recognized as a jumble, and when it was named correctly the square was always recognized at the same point. Some patients were reluctant to admit that they did not know which side of the target was being shown, and in these cases it was necessary to expose the target three or four times at each point so that the significance of their answers could be estimated.

The four most peripheral points at which each target was identified were marked on a chart and a line joining them formed an isopter of form perception. In cases with field defects, the targets were exhibited at points on the screen other than those mentioned. This was done at the discretion of the examiner so that defects could be more accurately outlined.

In cases where there was no measurable defect of form perception the patient was asked to give an opinion of the comparative clearness or definition of a square held at corresponding points in two quadrants or at two points lying on the same radius. His answers were not recorded unless they were consistent with

each target used, that is to say, the right or left was always thought to be the better side.

The lamps illuminating the screen were set so that in a subject with good vision the perception of form was equal in all quadrants. With the lighting used, a 2 mm. white target was seen by normal subjects at 20° to 30°, and 20° was found by experience to be the lower limit of normality even in the absence of refractive errors.

The pupils were examined in ordinary daylight and their size was not recorded unless they were very large or very small. No attempt was made to correct refractive errors as a routine procedure but advantage was taken of spectacles brought to hospital by the patients.

Material

Fifty hospital patients and thirteen normal subjects were studied. The patients form a highly selected group, for an attempt was made to include within the small compass of the series as many different types of lesions of the visual pathways as possible.

The patients were chosen according to the following criteria:

(*a*) They were fully co-operative in the examination, although formal psychological testing revealed some mental retardation in a few cases.

(*b*) They were all up-patients and were able to walk to the perimeter room.

(*c*) They were all cases in which perimetry was part of the routine investigation, and were, for the most part, cases in which field defects were reasonably suspected or were known to be present.

(*d*) They were all cases which either had no severe refractive errors, or had spectacles to correct such errors.

Results

The individual variation in extrafoveal form perception is considerable. Unfortunately the limitation of space prevents the reproduction of many charts, and to overcome this difficulty a classification has been adopted which will be used in describing cases. This classification (see Chart A, Fig. 2) depends on the position of one or two isopters as follows:

(*a*) Fields of form perception (FFP) less than average (< average).
Isopter to Target 2 lying within 15° to 20°.

(*b*) FFP average (average).
Isopter to Target 2 lying at 15° to 20° or at 20° to 25°, while isopter to Target 4 lies within 15° to 20°.

(*c*) FFP slightly better than average (> average).
Isopter to Target 4 lying at 15° to 20° or at 20° to 25°, while isopter to Target 5 lies within 15° to 20°.

(*d*) FFP much better than average (>> average).
Isopter to Target 5 lying at 15° to 20° or at 20° to 25°.

These categories will be employed regardless of the position of other isopters.

(A) Cases without Refractive Errors and without Defects in the Fields of Light and Form Perception.—This group comprises nine patients with normal vision and eight normal subjects. In all of these macular vision (MV) was Snellen 6/9 or better and FFP was average or better. The results are summarized in the Table (P1-9 and S1-8). None of the patients was shown by special investi-

TABLE

Correlation of the Size of the Fields of Form Perception with Macular Vision and Occupation.

Cases with Uncorrected Vision

No.	Occupation	MV R/L	FFP R/L	No.	Occupation	MV R/L	FFP R/L
S1	Secretary ...	4/4	A/A	P25	Aero engineer ...	6/5	A/A
S2	Nurse	6/9	>A/>A	P26	Organist ...	6/9	A/A
S3	Housewife ...	6/6	A/>A	P30	Baker	−/5	−/A
S4	Typist	6/6	A/A	P31	Engineer-fitter ...	12/5	A/A
S5	Porter	5/5	A/A	P40	Presskeeper ...	No PL/9	−/>A
S6	Secretary (drives car)	5/5	>>A/>>A	P41	Housewife ...	5/−	>> /−
S7	Nurse	5/5	>A/>A	P43	Housewife ...	9/9	A/A
S8	Foundryman ...	6/6	>>A/>>A	P49	Housewife ..	9/9	A/A
P1	Housewife ...	6/5	A/A	P50	Refrigeration engineer	6/9	A/A
P2	Schoolboy ...	5/5	A/A	S13	Porter	9/12	A/A
P3	Schoolboy ...	9/6	A/A	P10	Dressmaker ...	12/6	A/A
P4	Soldier	6/6	A/>A	P11	Ticket collector	18/18	>A/>A
P5	Housewife ...	6/9	A/A	P13	Innkeeper ...	24/12	A/A
P6	Labourer ...	6/6	A/A	P19	Cinema operator	−/12	−/A
P7	Baker	9/9	>A/>A	P21	Clerk	60/60	A/A
P8	Housewife (drives car)	6/6	>>A/>>A	P23	Compositor ...	9/18	>A/>A
P9	Electrical engineer	6/6	>>A/>>A	P27	Waiter	36/18	A/A
P22	Saleswoman ...	6/−	A/−	P28	Lorry driver ...	12/24	>>A/>A
				P45	Petty-officer ...	9/12	A/A
				P48	Foundryman ...	6/9	>>A/>>

Cases with Corrected Vision

No.	Occupation	Uncorrected Vision		Corrected Vision	
		MV	FFP	MV	FFP
S9	Physician	1/60 −1/60	<A/<A	9/18	A/A
S10	Porter	1/24 −1/24	<A/A	24/24	A/A
S11	Physician	1/18 −1/24	<A/A	5/9	A/A
S12	Physician (drives car) ...	36/60	>A/>A	5/6	>>A/>>A
P12	Warehouseman	— −1/18	−/A	−/18	−/A
P14	Housewife...	24/24	A/A	9/12	A/A
P15	Warehouseman	1/60 −1/24	<A/<A	9/18	A/A

P = patients; S = normal subjects. No case drives a car unless specified.

Macular vision (MV) is measured with Snellen type at 6 metres. The two terms Right (R) 6/12 and Left (L) 6/9 are given as 12/9. At distances less than 6 metres the terms are given in full.

The size of the fields (FFP) is given in terms of "average" (A) already defined. Patients are quoted only when they have presumably normal eye-fields or normal half-fields, and the fields are described in terms of these normal parts of the visual fields.

gations to have lesions of the visual pathways. In plotting the fields of light perception (FLP) the smallest target used was a white 1 mm.

Four subjects who were examined are not included in this group. These were physicians who, in their determined efforts to prevent their eyes from moving, stared fixedly at the centre of the screen and had little attention for the targets. In each case the FFP was grossly contracted. In addition their attention for the targets seemed to fluctuate and their answers were inconsistent. This difficulty did not arise in other cases whose answers were consistent throughout.

A study of this group of cases shows the great variation in extrafoveal form perception, although this tends to be masked by using a classification consisting of only four categories. The limits of normality, in terms of the size of the fields, are difficult to determine, for the upper limit is imposed by the method itself since Target 5 may be identified at 20° to 25° and the lower limit seems to depend on the subject's ability to fix his eye on the centre of the screen while allowing his attention to wander to the periphery. Nevertheless the variations in the size of the fields are not altogether a matter of chance, for it is possible to correlate them, to some extent, with the occupations of the subjects as shown in the Table.

In the absence of refractive errors and lesions of the visual pathways the perception of form is equal in all quadrants of the fields although an occasional isopter may show a localized contraction (Chart 1*, Fig. 3).

In all the cases in this group there is a fairly close similarity in the size of the FFP in the two eyes. Further cases show this to be true, provided there are no refractive errors or lesions of the visual pathways causing asymmetrical distortion of the fields.

When given an opportunity to compare the definition of a square on the right and left sides (or upper and lower quadrants) of the fields, all cases admitted that vision seemed to be equally good on both sides. With a square held at the centre and more peripherally each individual was acutely aware that the square was most clearly defined at the centre and that this definition became progressively impaired as the square was moved to the periphery until ultimately it could not be distinguished from the jumble.

It was found that vision did not readily fatigue while form perception was being tested and that changes in the fields could not easily be produced by continuous testing over about 10

* The charts are numbered according to the patients to whom they belong.

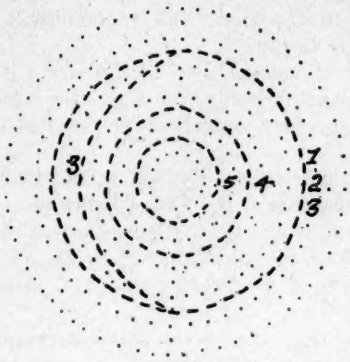


Chart 1.

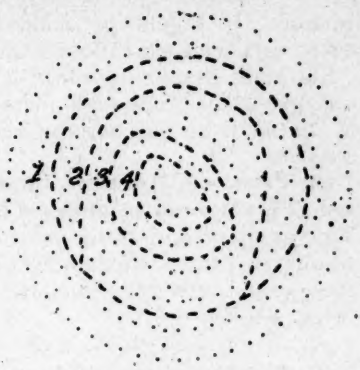


Chart 14.

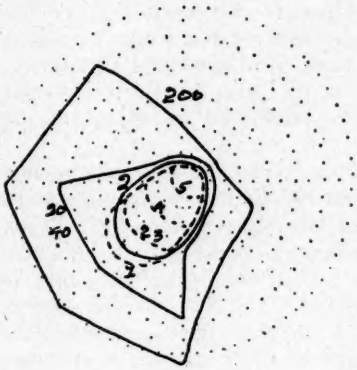


Chart 18.

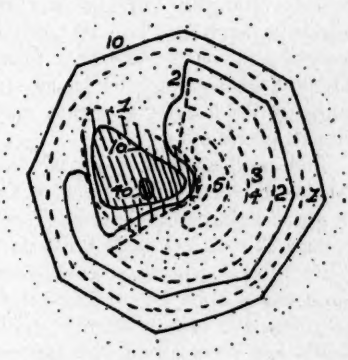


Chart 24.

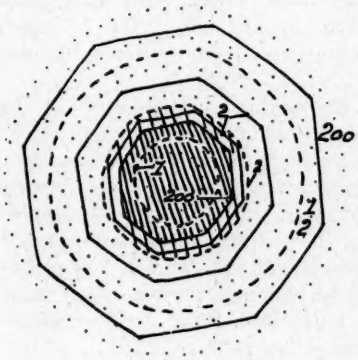


Chart 29.

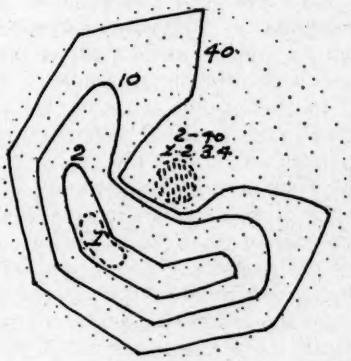


Chart 31.

FIG. 3.

minutes. It should be noticed that vision was momentarily rested between each exposure of the target.

Six cases were re-examined at intervals of 2 to 14 days and it was found that, although there were minor variations, the size of the fields on the basis of the present classification remained constant.

(B) Cases with Refractive Errors and without Defects in the FLP and FFP which can be attributed to Lesions of the Visual Pathways.—This group comprises six patients and five normal subjects. The results are summarized in the Table (P 10-15 and S 9-13). In these cases refractive errors are judged on the fact that MV falls below Snellen 6/9.

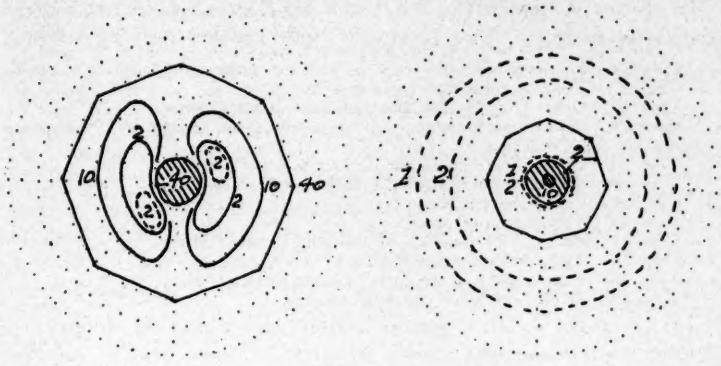
As in the first group it can be seen that better than average form perception is related to occupation. Patients 13, 14, and 15 showed considerable irregularity of the isopters, and these irregularities changed but did not disappear with correction of the refractive errors. The refractive errors were not studied and the irregularity of the isopters may have been due to astigmatism. The patterns of the FFP, as shown in Chart 14 (Fig. 3) do not suggest field defects which can be attributed to lesions of the visual pathways.

The cases in this group are too few to attempt a detailed correlation between refractive errors and the FFP but the impression is gained that the lesser degrees of refractive errors which do not reduce MV below 6/24 have no influence on the size of the fields. This impression is strengthened by the fact that correction in such cases does not enlarge the fields. The more severe degrees of refractive errors seem to have a variable effect, and when the fields are reduced in size correction of the refractive errors may allow the fields to assume " average " proportions.

(C) Cases with Distortion of the Visual Fields other than those produced by Refractive Errors.—This group comprises 34 cases which, by means of various investigations, were shown to have lesions within the cranium*.

In this group it is necessary to attempt a correlation of the FLP and the FFP. This correlation is made in respect of the pattern and size of the fields. The pattern of the fields is assessed by considering the grouping of all the isopters making up each type of field, and attention is given to the shape as opposed to the size of the fields. The size of the fields is measured in terms of the isopters of the 2 mm. white target and Target 2, the size being measured with corrected vision when refractive errors cause contraction of the fields. The FFP and FLP are considered equal if the two isopters fall within 5° of each other.

*In all cases of neoplasm in Group C the lesions were verified by biopsy or at operation except in Cases 20, 22, and 48.



A B

Chart 41. Left eye.

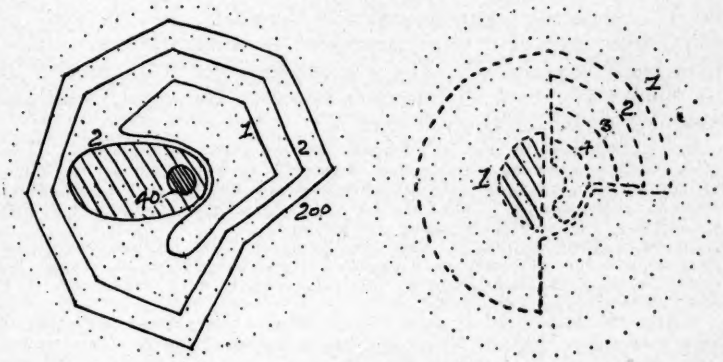


Chart 44.

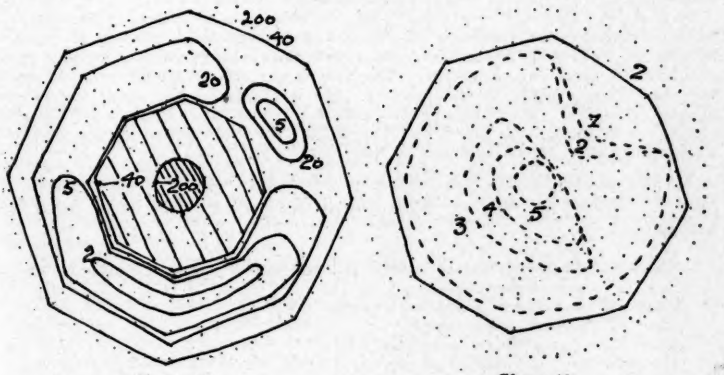


Chart 32. Chart 49.

FIG. 4.

1. *Cases in which the FLP and FFP are Similar in Pattern and Equal in Size.*—The diagnoses in this group were as follows:

Case 16. Post-concussional syndrome with functional contraction of the fields.
Case 17. Tabes dorsalis with optic atrophy.
Case 18. Optic atrophy due to severe gastric haemorrhage.
Case 19. Optic atrophy secondary to papilloedema caused by 3rd-ventricle colloid cyst.
Case 20. Unconfirmed parasellar tumour with hemianopia.
Cases 21 and 22. Pituitary chromophobe adenoma.
Case 23. Craniopharyngioma.
Case 24. Tobacco amblyopia.
Cases 25 and 26. Thrombosis of posterior cerebral artery.
Case 27. Temporal lobe meningioma.
Case 28. Unconfirmed thrombosis of brain stem vessel.
Case 29. Senile exudative choroidoretinitis.

In all cases in this group vision was either stationary, or deterioration was only slowly progressive over several months. In the charts the isopters of light perception are marked in continuous lines and the isopters of form perception in interrupted lines. Similarly, light perception scotomata are enclosed in continuous lines and form perception scotomata in interrupted lines and cross-hatched. The size of the target in millimetres or its number is placed against each isopter. The charts represent examination on the Bjerrum screen.

Patient 18 (Chart 18, Fig. 3). Female, aged 54 years. Kitchen hand. Loss of sight followed a severe haematemesis 33 years before present admission. Vision of right eye recovered completely, according to patient, and left eye remained blind. Bilateral optic atrophy. MV: L, No PL; R, 6/18 uncorrected, 6/9 with spectacles. FLP and FFP—irregular contraction.

Patient 24 (Chart 24, Fig. 3). Male, aged 55 years. Clerk. Tobacco amblyopia. Progressive failure of vision for 5 months but no change in recent weeks. No change in the fields after 3 months. MV: L, 2/36. R, 6/18 uncorrected. FLP and FFP—centrocaecal scotomata.

Patient 28. Male, aged 48 years. Lorry driver. Unconfirmed thrombosis of brain stem vessel. Left eye always lazy but no history of squint. Disks normal. MV: L, 6/24; R, 6/12 uncorrected. FLP—a 2° central scotoma in left eye-field. FFP—subjectively Target 5 more clearly defined at 5° than at centre. Otherwise right eye-field $\gg$ average, left eye-field $>$ average.

Patient 29 (Chart 29, Fig. 3). Male, aged 70 years. Retired storekeeper. Bilateral degenerative condition of retina and choroid with exudate at macula. Progressive failure of vision for 2 years with little change in few months prior to admission according to patient. The patient was able to see furniture in room but could not identify smaller objects. He was able to get about the streets without difficulty. MV: R and L 1/60, J20. FLP and FFP—a 15° central scotoma with the 2 mm. target and Target 2. The difficulty in fixation prevents a close correlation between the size of the fields.

2. *Cases in which the FLP and the FFP are Similar in Pattern but Unequal in Size.*—The diagnoses in this group were as follows:

Case 30. Recurrent mania. This patient had a latent strabismus and a central scotoma as in Case 28.
Case 31. Sphenoidal ridge meningioma.
Case 32. Leber's optic atrophy.
Case 33. Suprasellar meningioma.
Cases 34 and 37. Parietal glioma.

Case 35. Parietal meningioma.
Case 36. Temporo-parietal glioma.
Case 38. Meningioma over lower end of Sylvian fissure causing severe papilloedema.
Cases 39 and 42. Aneurysm in region of optic chiasma.
Case 40. Dermoid cyst of pituitary fossa.
Case 41. Syphilitic neuro-retinitis.

In some of the cases of this group vision was deteriorating rapidly or improving rapidly either as the result of treatment or spontaneously as in the case of the aneurysms. In all others there was mental retardation (see Summary of Results). Case 32 was an exception in that vision was stationary, but here the isopter to the 2 mm. target was so reduced that a correlation of the FLP and FFP was impossible. The case is included here, however, for convenience.

Patient 31 (Chart 31, Fig. 3). Male, aged 41 years. Engineer fitter. Sphenoidal ridge meningioma. Progressive loss of vision in right eye for 1 year becoming more rapid recently. MV: L, 6/5; R, 6/12. Central vision in right eye fluctuated during the examination. The left eye-field was full and average.

Patient 32 (Chart 32, Fig. 4). Male, aged 33 years. Coach finisher. Leber's optic atrophy. Loss of vision in L eye for 11 months and in R eye for 8 months. Vision amounted only to discrimination between light and shade. None of the targets of form perception were identified.

Patient 41 (Chart 41, Fig. 4). Female, aged 29 years. Housewife with two young children. Works in a factory, packing cakes in boxes. Syphilitic neuro-retinitis. FLP and FFP in left eye-field—Chart B was taken 2 weeks after Chart A, penicillin having been given during the interval. Chart B shows that, while vision was improving, the isopter to Target 2 was greater (5°) than the isopter to the 2 mm. target. In the R eye-field there was a diminution of form perception in the R lower quadrant although the FLP was full. At the time of Chart B this defect had disappeared and the whole field had improved from average to >> average.

3. *Cases in which the FLP and the FFP are Dissimilar in Pattern.*

(i) *Cases with distorted FLP.*—The diagnoses in this group were as follows:

Case 43. Frontal meningioma.
Case 44. Neoplasm in relation to optic nerve.
Case 45. Glioma of temporal lobe with marked papilloedema. In this there was a hemianopia in the FFP while the FLP were concentrically contracted. A hemianopia in the FLP developed after a needle biopsy.

Patient 44 (Chart 44, Fig. 4). Male, aged 45 years. Engineer fitter. At operation a small neoplasm was found under the left optic nerve immediately anterior to the chiasma. No attempt was made to remove the tumour or define its boundaries in relation to the chiasma or tracts. Progressive failure of vision for 6 months. A follow-up of this case showed that the progressive failure of vision was more apparent in the FFP than in the FLP. In the charts the right lower quadrantic defect is homonymous while the centrocaecal scotoma was found only in the left eye.

(ii) *Cases with Full FLP.*—The diagnoses in this group were as follows:

Case 46. Parietal glioma.
Case 47. Temporo-parietal glioma.
Case 48. Fronto-parietal glioma.
Case 49. Meningioma in floor of middle fossa.
Case 50. Naso-pharyngeal epithelioma.

In all the cases in this group the fields of colour perception were full on the screen (except 46, in which colour perception was not examined), and the fields of light perception were full to a 1 mm. and 2 mm. target on the screen and to a 1·5 mm. target on the perimeter.

Patient 49 (Chart 49, Fig. 4). Female, aged 38 years. Housewife. At operation a meningioma in the floor of the left middle fossa. Disks normal. MV: R and L, 6/9 uncorrected. FFP—incongruous right homonymous hemianopia. A dense right hemianopia in the FLP followed operation.

Summary of Results found in Group C*.—The numbers of all the cases are given in order to show the proportion presenting each type of result. The numbers of cases are given in bold type when they have previously been given as examples.

Cases 16 to 42 (**18, 24, 28, 29, 31, 41**) show that the FLP and the FFP have essentially a similar pattern.

Cases 38, 42, 43 and **44** show that a complex defect in FLP may be clarified in the FFP.

Cases 16 to 29 (examples as above) show that when vision is stationary or only slowly changing the FLP and the FFP are equal in size (within 5°).

Cases **31,** *33,* **41,** *42,* **44** show that when vision is rapidly deteriorating the FFP is smaller (5°+) than the FLP in the affected parts of the fields.

Cases 30, 34, 36, 37, 46 show that when there is mental retardation the FFP is smaller than the FLP over the entire field.

Cases 38 and 45 show that when the fields are contracted due to papilloedema the FFP is larger (5°+) than the FLP.

Cases 39, 40, and **41** show than when the fields are rapidly expanding the FFP is larger than the FLP.

Case **29** shows that the ability to identify target 2 over a fairly wide area of the central fields, although a central scotoma is present, may be a measure of the usefulness of vision in respect of getting about the streets.

Case **32** shows that an inability to identify target 2 anywhere in the central fields, although the 2 mm. target can be seen, may be associated with vision which for practical purposes is reduced to discrimination between light and shade, that is, to virtual blindness.

Cases 45 to 50 (**49**) show that a defect in the FFP may be present while the FLP and colour perception are full.

Case 28 shows that the depression of central vision, which is probably the result of latent strabismus, is apparent to the patient in the test of form perception. The FFP may otherwise be greater than average.

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*Note: Case 17 was the only one in which the size of the pupils was abnormal.

Discussion

The variability of extrafoveal perception of form described by Wertheim (1894), Low (1943), and others has been substantiated by the present investigation. It became evident, however, that these variations are not altogether a matter of chance since it is possible, to a certain extent, to correlate the fields of form perception with occupation. That people with occupations requiring good peripheral vision should have better than average extrafoveal perception of form is to be expected, and proves in an indirect way the point made by Rivers (1900) and Low that extrafoveal form perception can be trained.

The lack of close correlation between refractive errors and extrafoveal form perception, which was demonstrated by Low, is also confirmed by the present investigation. Yet some relationship does exist and when severe refractive errors are present the fields of form perception are contracted. This contraction can be abolished by correction of the refractive errors. This improvement in the fields occurs coincidently with the improvement in macular vision so that there is little to be gained in testing peripheral vision when spectacles are prescribed.

The present method allows the perception of form to be tested in individuals with central scotomata and in such cases may enable spectacles to be prescribed when severe refractive errors are present. Measurement of extrafoveal perception of form in such cases may be helpful also in the assessment of the usefulness of peripheral vision although to do this with accuracy a large number of cases will require to be studied.

The factors influencing the comparative sizes of the fields of light and form perception are of interest but at the moment seem of little practical value. Moreover since it is impossible to estimate the size of the fields before the onset of disease and since the size of the fields is so easily reduced by psychological factors it follows that the measurements of size cannot find a place as a clinical routine.

The comparison of the patterns of the fields of light and form perception is of more practical interest. By correlating the two types of fields, and also by correlating the fields of form perception with other clinical studies, it has been proved fairly conclusively that defects in the fields of form perception are a reliable guide to lesions of the visual pathways. Although they rarely give additional information when the fields of light perception are distorted, they may, in an appreciable number of cases, show defects before these become apparent in the fields of light and colour perception. This is possible since the fields

of form perception as charted by the present method lie mainly within the isopters of the 1 mm. and 2 mm. white targets which, when full, leave the greater part of the central fields uncharted. It is reasonable to suppose that, on the basis of the evolution of visual function, the perception of form would show impairment before that of light and that on the same basis the perception of colour would show impairment before either. That the latter is not the case can only be referred to the inaccuracy of colour perimetry.

There is no doubt that the test of form perception has several advantages over the tests of light and colour perception. The patient is spared the difficult task of dissociating the target from the rod supporting it, as in testing light perception with small targets; it is possible for the examiner to exclude guess-work on the part of the patient; there is no great tendency to fatigue as in colour testing; from the patient's point of view the test is easier than that of colour testing; and the test allows the patient to make a comparison of various parts of the fields, a procedure which brings the test into line with other forms of sensory testing.

The value of extrafoveal form perception testing would therefore seem to be threefold. It can reveal an early defect; it can confirm an equivocal defect in the fields of light and colour perception; and it tends to reduce a complicated defect in the fields of light perception to a simpler pattern. It is suggested therefore that the method be reserved for cases having fields of light perception which are full, equivocal, or bizarre. When the fields of light perception are full, the method of testing form perception need not be pursued if Target 2 reveals no defect; but should a defect be found it is important to remember that the other isopters must be charted, since refractive errors sometimes cause a distortion of only one isopter.

Summary

(1) A method of testing extrafoveal perception of form is described.

(2) The results of testing thirteen normal subjects and fifty patients are detailed.

(3) The variability of extrafoveal form perception is demonstrated and a classification of variations suggested.

(4) It is suggested that variations can be related to occupation.

(5) The effect of refractive errors on the fields of form perception are described.

(6) The comparative sizes of the fields of light and form perception are shown to be related to several factors.

(7) It is shown that a defect in form perception can be revealed before a defect in light or colour perception.

(8) It is proved that a distortion of the fields of form perception is a reliable indication of a lesion of the visual pathways.

(9) Other advantages of form perception testing are discussed.

I wish to convey my thanks to the members of the staff of the National Hospital for Nervous Diseases for allowing me to use their cases and hospital records.

REFERENCES

AKELAITIS, A. J. (1942). *Arch. Neurol. Psychiat., Chicago*, **48**, 108.
BENDER, M. B., and KANZER, M. G. (1939). *Brain*, **62**, 404.
DOBROWOLSKY, W., and GAINE, A. (1876). *Pflüg. Arch. ges. Physiol.*, **12**, 411.
DUKE-ELDER, S. (1938). "Text-book of Ophthalmology", vol. I, p. 930. Kimpton, London.
EVANS, J. N. (1929). *Amer. J. Ophthal.*, **12**, 194.
GRINDLEY, G. C. (1931). *Spec. Rep. Ser. med. Res. Coun., Lond.*, No. 163.
LOW, F. N. (1943). *Amer. J. Physiol.*, **140**, 83.
LUDVIGH, E. (1941). *Amer. J. Ophthal.*, **24**, 303.
PARSONS, J. H. (1927). "An Introduction to the Theory of Perception", pp. 52, 182. University Press, Cambridge.
RIVERS, W. H. R. (1900). In "Text-book of Physiology", ed. E. A. Schäfer, 2nd ed., vol. 2, p. 1086. Pentland, Edinburgh.
SALAMAN, M. (1929). *Spec. Rep. Ser. med. Res. Coun., Lond.*, No. 136.
TRAQUAIR, H. M. (1942). "An Introduction to Clinical Perimetry", 4th ed. Kimpton, London.
WERTHEIM, T. (1894). *Z. Psychol. Physiol. Sinnesorg.*, **7**, 172.
WOODWORTH, R. S. (1938). "Experimental Psychology", pp. 623, 684. Holt, New York.

INTRAMURAL VESSELS AND ENDOTHELIAL CELLS IN THE WALLS OF SCLEROSED RETINAL ARTERIES*†

BY

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ARTERIO-SCLEROTIC vessels are clinically and histologically important. I have studied retinal material, especially the tissue of fatty change for a great number of years. The chemical nature of the fat is still practically unknown. I have now studied sclerosed retinal arteries systematically. First I examined the unstained tissue, then I used the technique of retina in bulk. Later I combined the bulk technique with staining, mainly with haematoxylin, Weigert, or sudan red. It seems to be important that the first vasa vasorum shown in the retina of the human eye were in the walls of these sclerosed retinal arteries. (Loewenstein, 1947 a, b; 1948 a, b.)

In the literature, intramural vessels in the ascending aorta and in the coronary artery have been described by Robert (1929), who found a discrete capillary system in the intima of the aorta. Paterson (1936) mentioned vascularization of coronary arteries in association with arterio-sclerosis. It is most important that Paterson never discovered intramural vessels in *normal* arteries. As far as I understand him, he did not find any newly formed vessels in the arteries either of humans or of normal animals.

Winternitz and others (1938), produced a perfect specimen demonstrating the vasa vasorum in sclerosed coronary arteries. The tissue of the arteries was cleared and injected with black ink, and showed the presence of a typical network of vasa vasorum in the rich vascular system of the intima. Of course, it is much easier to work on these huge arteries than on our small retinal vessels. But I frequently found intramural vessels in the retina, especially as our technique improved. The fine sclerosed vessels came out very clearly, especially with reduced light and frequent change of the iris diaphragm.

We know, of course, that cases of arterio-sclerosis appear clinically as a ramified rete mirabile. Ballantyne (1949) has shown typical retinal and preretinal vessels by ophthalmoscopic examination. In our histological material we demonstrated new vessels, the " vasa vasorum". This material was mostly arterio-

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sclerotic with hypertension, but vasa vasorum could be shown quite frequently in diabetes, and also in thrombosis of the central vein, often combined with arterio-sclerosis. We discovered them in three cases of periarteritis nodosa and in two cases of vasculitis of young adults with haemorrhages in the retina and vitreous. These intramural vessels are most interesting but not fully understood either in periarteritis nodosa or in vasculitis.

FIG. 1.—Intramural vessels. Retina in bulk, with thrombosis of the central vein. The artery in the retina shows the thickened wall. Haematoxylin. 300×.

The retinal tissue must be carefully cleaned with a brush to remove the blood, then stained as described, and kept in glycerine. Later the material is examined in glycerine jelly. When we study the retinal tissue in bulk we look for the lumen of the artery and its wall (Fig. 1). In bulk the ganglion cells of the retina appear dark blue. We recognize the lumen which is mostly filled with red blood corpuscles, variable in diameter, sometimes dilated, sometimes narrow. These sclerosed walls appear whitish, swollen, and irregular. The intramural capillaries are sharply delineated and filled with thin red blood corpuscles (Fig. 1); they are perfectly visible in bulk. The oblong blood corpuscles are characteristic for the thin intramural vessels where they frequently run along the lumen. Other intramural capillaries are arranged in spirals or transversely (Fig. 6). These intramural capillaries are most

frequently present in the area of the whitish sclerosed walls on both sides of the red lumen with its round red blood corpuscles (Fig. 1).

These fine capillaries in the wall were stained in bulk in a tissue of exactly 0·5 mm. in length and photographed. There was no intramural vessel on either side of this part of the artery.

That part of the artery with the intramural vessels was then embedded in paraffin and cut in serial sections. We studied especially sections 230 to 280 where we found the intramural vessels exactly in the wall. In these sections one sees the capillaries filled with red blood corpuscles (Fig. 2); there are no capillaries before 230 or after 280. The vasa vasorum only appear in the piece of artery between these two sections (Fig. 2 *a*).

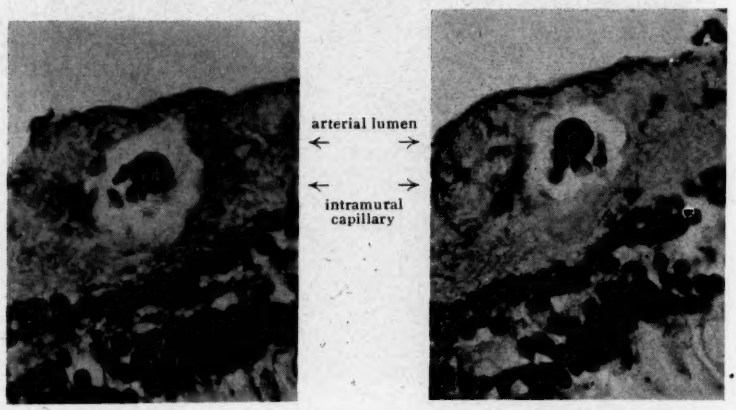

FIG. 2 (*a*) and (*b*).—Intramural vessels in paraffin sections, showing sclerosed walls. Intramural capillaries filled with red blood corpuscles. Series between 230 and 280, single 50 sections of 10μ = 0·5 mm.

In the sections before 230 and after 280, where there were no intramural capillaries, we found endothelial cells which are certainly pathological (Fig. 3 *a* and *b*). I cannot offer an explanation for these endothelial cells; they might be growing from the endothelium of the lumen or be newly growing capillaries without any red blood corpuscles. We have already seen endothelial cells growing out of the lumen of arteries in previous sections. It is possible that the blood fills the intramural vessels at a later stage (Fig. 3 *c* and *d*). In any case these endothelial cells in the pathological walls require intensive study in bulk as well as in sections.

In one of the cases of periarteritis nodosa there can be seen part of the thrombosed vessel overbridged by newly formed intramural vessels (Fig. 4).

Fig. 5 shows a sclerosed vessel with intramural capillaries and fatty changes. The tissue was stained in bulk with haematoxylin and sudan red, and the fat in the walls appears shining red. It is quite frequent to find both processes in the sclerosed vessels—intramural vessels and fatty change.

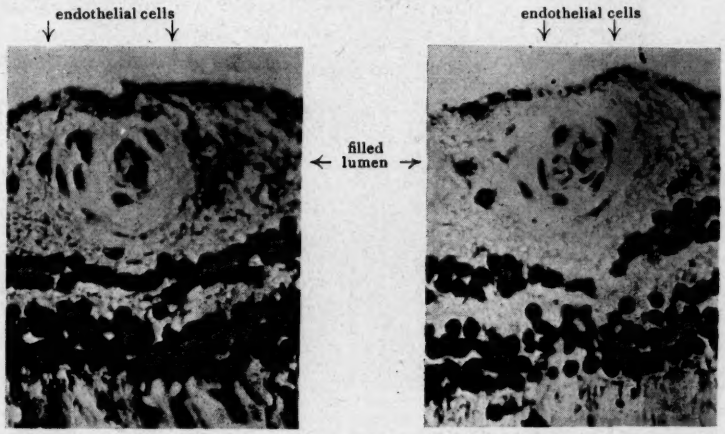

FIG. 3 (*a*) and (*b*).—Sclerosed retinal artery. Lumen filled with red blood corpuscles. Endothelial cells in the sclerosed wall.

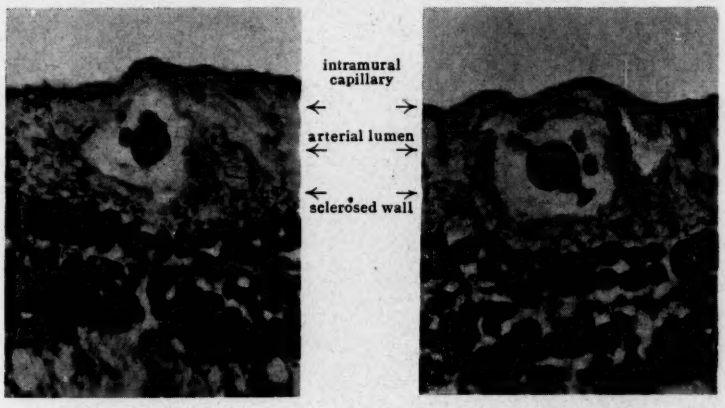

FIG. 3 (*c*) and (*d*).—Intramural capillaries with red blood corpuscles.

So far I have described intramural vessels in arteries rather than in veins; but we found vasa vasorum in the walls of two *crossing* vessels. I therefore conclude that intramural vessels

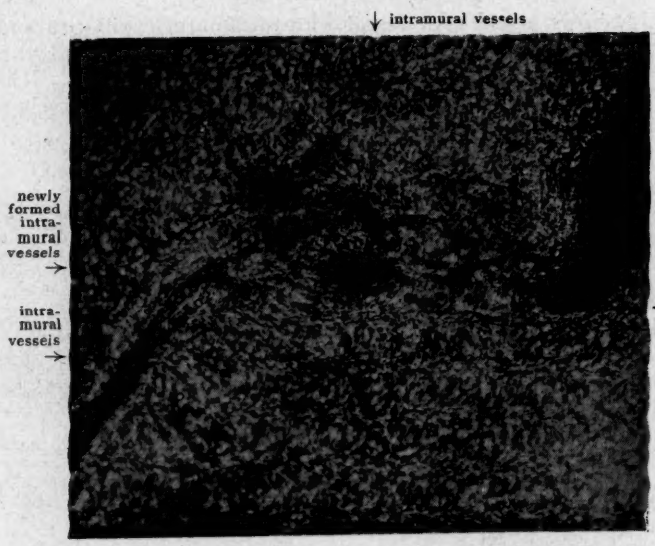

FIG. 4.—Periarteritis nodosa. Retina in bulk. The thrombotic process has produced a new formation of overbridging vessels. Anilin blue. 150× approx.

FIG. 5.—Hypertensive and diabetic arteries containing intramural vessels. Whole wall filled with fatty necrosis. Stained in bulk, haematoxylin and scarlet red. 150×.

are also present in *veins*. The vessels in veins and in arteries have a different appearance. The thrombotic closure of veins leads to the formation of by-passing vessels within the walls of the vein. In the sclerosed artery, however, those intramural vessels do not by-pass any particular part of the lumen, but ramify in the walls of the parent vessel. Figs. 6 (*a*) and (*b*) especially show the clear difference in the two modes of new-vessel formation; Fig. 6 (*a*) shows the new vessels spiralling round the parent vessel and ramifying in the substance of the walls, while Fig. 6 (*b*) shows the more direct course of the vasa vasorum in the occluded vein.

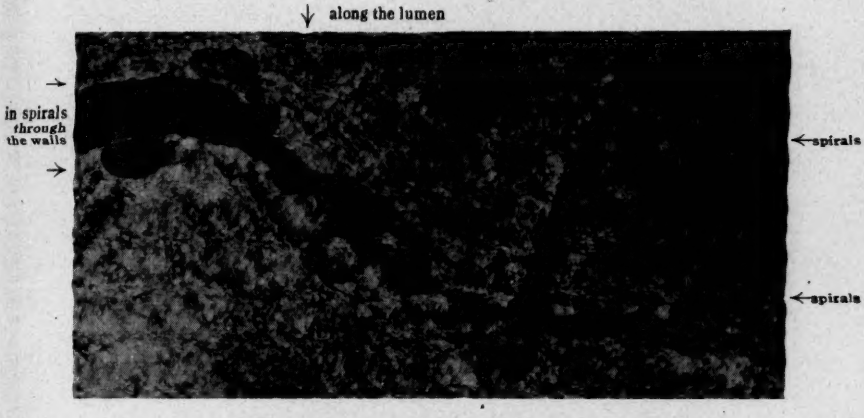

FIG. 6 (*a*) —Intramural vessels (arteries)—in the retina—in spirals through the wall.

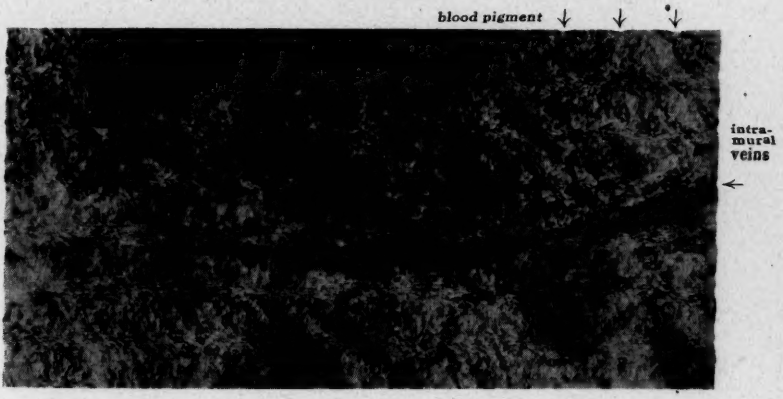

FIG. 6 (*b*).—Intramural vessels (veins) in thrombosis.

Hitherto I have discussed intramural vessels in the aorta and coronary arteries, and in the arteries of the retina. There is a probability that the vessels of other tissues have different vasa vasorum. I have tried to find these in brain tissue, using different techniques, such as injecting the medium-sized vessels with ink, or clearing the very fine cerebral vessels, but so far without success. I have previously shown the vasa vasorum in the retina in sketches. The microscopical stereoscopical depth appears in bulk vessels between 30 and 40μ (Loewenstein, 1948). This communication contains photomicrographs only; they are in different positions, some high, some deep.

Conclusion

(1) Intramural vessels are shown in photomicrographs of the retina in bulk. One shows an intramural vessel 0·5 mm. in length.

(2) Some of these intramural arteries are shown in serial paraffin sections of the same length (0.5 mm.).

(3) Endothelial cells are visible in the sclerosed arterial wall. These endothelial cells might possibly be capillaries without red blood cells.

(4) Intramural vessels are present in both arteries and veins.

(5) Intramural vessels are shown in a case of periarteritis nodosa.

I am indebted to Mr. John Watt for his help in histological work and for his photomicrographs.

REFERENCES

BALLANTYNE, A. J. (1949). *Ophthalmologica, Basel*, **118**, 611.
LOEWENSTEIN, A. (1947a). *Nature, Lond.*, **160**, 124.
——— (1947b). *Trans. ophthal. Soc. U.K.*, **66**, 581.
——— (1948a). *Arch. Ophthal., Chicago*, **39**, 9.
——— (1948b). *British Journal of Ophthalmology*, **32**, 748.
PATERSON, J. C. (1936). *Arch. Path.*, **22**, 313.
ROBERTSON, H. F. (1929). *Ibid.*, **8**, 881.
WINTERNITZ, M. C., THOMAS, R. M., and LECOMPTE, P. M. (1938). "The Biology of Arteriosclerosis". Thomas, Springfield, Ill.

A COMPARATIVE STUDY OF COAL MINERS' NYSTAGMUS*

BY

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Introduction

RIVERS (1922), Culpin (1925, 1932), and Stern (1948) have suggested that coal miners' nystagmus is essentially psychological in origin, but on the other hand, ophthalmological opinion (Ferguson, 1939; 1943) tends to support the conclusion of the first report of the Medical Research Council's miners' nystagmus committee (1922), that the most important element in the cause of the disease is lack of light. Moreover, nowadays it is often remarked by colliery managers that the disease tends to attack some of their best workmen. There is very little social information about men with nystagmus, and in the only comparison which appears to have been made between men with and without the disease, it was found (Stern, 1948) that fifteen out of twenty-three men without the disease were apparently psychologically abnormal.

Prevention of the disease is an administrative problem, and if it is largely psychological, the administrator may well feel that it is not worth while to spend large sums on better colliery lighting. He may rather ask for guidance about selection tests to eliminate susceptible individuals.

Moreover, in order to frame a resettlement policy, it is necessary to have some idea of what a miner disabled with this disease can do, and a survey of what he *does* do when left to himself may be useful.

This enquiry, therefore, has been designed in an attempt to shed light upon the following questions:

(1) How does the social and occupational life of a coal miner who suffers from nystagmus differ from that of one who does not?
(2) Do coal miners with this disease differ physically from those without it?
(3) What work are men with this disease capable of doing?

Method

Five years before the start of the survey, 225 miners in County Durham were granted certificates of disablement by nystagmus.

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A random sample of fifty of these men was taken, a meeting arranged, and a simple explanation delivered to them. A special clinic was instituted where the medical, family, and occupational histories were taken and each man was given a full physical examination. If oscillation of the eyes was not obvious, they were examined with an ophthalmoscope after stooping, or after being in a dark room for 15 minutes. Only three of these fifty men did not come for examination. One refused, one was ill, and one had moved to the South of England. The production of a true control group of normal men with whom these could be compared, presented two fundamental difficulties. First, in civilian life it is not possible to carry out a medical examination of a fit man unless he gives his consent. He is, therefore, *ipso facto* a volunteer. Secondly, there were no centralized records of the miners in the county from which a statistically random selection could be made. If, therefore, the observations were to be controlled at all, it seemed necessary to combine what was statistically desirable with what was practically possible. It was not thought valid to use men who were in hospital with other diseases, since they are by definition not normal, and moreover, their pulses and blood pressures, which were to be measured, might well have been affected by their condition. In this study a group of volunteers not suffering from nystagmus (Table I), matched in respect of age and occupation, was therefore chosen by selecting a random fifty out of the 162 miners' lodges in County Durham, and by asking each of these to nominate one man to

TABLE I

Nystagmus and Control Groups, by Age and Job.

Present Age	Employment										Total	
	Hewer		"Putter"		Filler		Stoneman		Rolley Weighman			
	N.	C.	N.	C.	N.	C.	N.	C.	N.	C.	N.	C.
-30	0	1	0	0	0	0	0	0	0	0	0	1
30–39	12	10	0	0	0	0	0	0	0	0	12	10
40–49	13	13	2	2	0	1	1	1	0	0	16	17
50–59	12	15	0	0	2	1	2	2	1	1	17	19
60	2	2	0	0	0	0	0	0	0	0	2	2
Total	39	41	2	2	2	2	3	3	1	1	47	49

match each of the nine age and occupation groups into which the men with nystagmus fell. This produced 450 names, from whom a final random selection of 49 was made, all of whom presented themselves for a medical and social examination comparable in every respect to that given to the men with the disease. It was important to make the selection of the controls as random as possible, but, at the same time, to avoid any wastage through men not arriving for examination, since this itself produces a selected sample.

The clinician saw each man first and took the present and past history of the disease, together with the past history of any other illnesses. His family history was noted in full, and consisted of the age, occupation, present health or cause of death, of father, mother, wife, brothers, sisters, and children. A note was then made of any accidents which had happened to the patient or which he had seen. The employment (or unemployment) history was then taken by the method advocated by Meiklejohn (1949), in which the nature of the present job is determined in detail, together with a complete employment history from the start of work up to the present time. The physical examination included height, weight, pulse rate, blood pressure, and chest expansion.

After the clinical examination, an almoner saw each man privately, noted his financial situation, and enquired about his early life and the reasons for entering coal mining. She also made a subjective assessment of intelligence, arranged a visit to his home, where she met the patient's wife and assessed the home accommodation. The men's intelligence, the " personalities " of their wives, their household standards, and physical accommodation, were graded on a single three-point scale, together with any domestic strain encountered.

Limitations of the Method.—The main limitation in the historical data was memory, so that the reliability of the research cannot be considered to be greater than that of the usual type of clinical history. But, at the same time, it is no less. In the past symptoms have been grouped merely under the main systems, as set out in the international statistical classification (1948) and no special diagnosis, other than that of peptic ulcer, has been attempted. In regard to the occupational histories, periods of unemployment are well remembered because of the financial hardship involved, and so are times in the armed forces. Coal miners climb their professional ladder in fairly regular steps, and usually say quite confidently at what age they started certain work. The age when a man starts coal-face work and the age when he gives it up are nearly always accurately remembered, because of the financial implications.

The limitations of the social worker's subjective assessments are perhaps rather greater, and more weight can be placed upon them when they confirm tendencies already apparent, than when they do not. Subjective assessments were made by the same person throughout, and were recorded before any analysis of the data was made. In theory, it would have been better if the social worker had not known which men had nystagmus and which had not, but in practice this is not possible, as it can be deduced from their conversation.

A further limitation of this work is in the volunteer composition of the normal group, but there was no wastage, and its bias was towards a better than average group, so that in the event it turned out that the comparison was made more and not less severe, and that the bias was against and not in favour of the men with nystagmus.

TABLE II

Number of Cases showing Various Symptoms at Three Points of Time.

Symptom	Presenting		At Certification		Five Years after Certification	
	No. of Cases	%	No. of Cases	%	No. of Cases	%
Unsteadiness	12	25	46	96	18	38
Photophobia	2	4	45	94	2	4
Headache	13	27	41	85	21	44
Moving objects	19	40	42	87	1	2
Night blindness ...	—	—	38	79	—	—
Anxiety	—	—	16	33	5	10
Depression	—	—	13	27	3	6
Insomnia	1	2	32	67	—	—
Irritability	—	—	31	65	—	—
Fear at work	1	2	7	15	3	6
Nausea and vomiting ...	—	—	6	12	1	2
Faintness	—	—	6	12	—	—
Fatigue	—	—	6	12	3	6
None	—	—	—	—	16	33

Results

(a) Symptoms and Signs.—Forty-seven of the men had had one attack of the disease and one man had had two. The commonest presenting symptom in this series of cases was a complaint that objects—usually the lights in the pit—appeared to be moving (Table II). Unsteadiness, more marked in the dark and especially on meeting a bright light or on stooping, was second in order of frequency. This is often described as dizziness or giddiness, and sometimes by doctors as vertigo, but careful enquiry shows that the patient usually means that he becomes unsteady on his legs, a symptom which causes some anxiety to men working in the dark, surrounded by machinery. In no case was there anxiety or depression in the early stages of the illness. The length of time between the first symptom and certification is very variable

TABLE III

Relation between Number of Attacks of Nystagmus and Time between First Symptom and Certification.

Time (months)	Attacks				Time (years)
	No.	%	No.	%	
0— 6	15	31	0	0	5—
7—12	7	15	1	2	6—
13—18	5	10	0	0	7—
19—24	9	19	0	0	8—
25—30	0	0	3	6	9—
31—35	2	4	1	2	10—
36—42	1	2	—	—	—
43—48	2	4	—	—	—
49	2	4	—	—	—

(Table III). In slightly less than one-third of the attacks it is less than six months, but more than half the men put up with the disease for more than a year before becoming certified. At this point there is an expansion of the symptomatology. There is an increase in the symptoms which were common on presentation, such as unsteadiness, headache (which may have a very varied distribution), and the apparent movement of objects. There is also a widening of the range of complaints and the appearance of new symptoms. For example (Table II), anxiety and depression are found in about one-third of attacks, and insomnia and

irritability in about two-thirds. Five years later—and most of the patients had been out of the pit for this length of time—the symptomatic pattern has again changed. One-third of the patients have no complaints, but unsteadiness and headache are still common. Anxiety and depression are still present, but less commonly than five years before. On the whole, the frequency of the symptoms is less and their range has contracted.

The general physical findings in both the nystagmus and control groups are summarized in Table IV. The mean ages differed by slightly more than two months, the heights by less than half an inch, and the weights by little more than a pound. The average pulse rate of the men with nystagmus is only two beats per minute more than that of the normal group. The two groups have identical systolic blood pressures, but the average diastolic pressure of the men with the disease is 8 mm. Hg higher than that of the controls. The chest expansions of the two groups are not significantly different.

TABLE IV

Physical Findings.

Particulars	Nystagmus	Controls	Difference	Standard Error
Age (years)	47·7	47·5	0·2	1·86
Height (inches)	67·0	67·5	0·46	1·60
Weight (lbs)	150·1	151·4	1·31	4·29
Pulse (beats/min.) ...	70·2	67·7	2·51	1·05
Blood Pressure (mm.Hg)	145 91·4	145 83·4	0·00 8·00	4·42 2·88
Chest Expansion (inches)	1·9	1·8	0·1	0·14

Table V compares the past illnesses of the two groups. More men with nystagmus than controls had had no illnesses; the controls seemed to suffer more with their chests. There is no evidence in this study that men who have nystagmus fall sick more often than usual. The past medical history of this group is well summed up in the words of one of them, " I've only been off four shifts in my life—all for funerals ".

(b) Occupational Histories.—A numerical comparison of the occupational histories of the men with nystagmus, before certification, and the normal men is made in Table VI. " Surface work " includes work in the screens, in the timber yard, labouring, and " at bank " in the local phraseology. " Haulage work " includes

the jobs of haulage hand and trapper-boy (a boy who opens and shuts a door in an air lock for the pony and tubs to go through), pony-driving, and " datal work " (*i.e.*, odd jobs underground paid at a daily rate). " Putting " is a corruption for pushing tubs, which is done either by hand or with the help of a pony.

TABLE V

Past Illnesses Classified.

Type of Disease	Nystagmus	Controls
Infectious	11	4
Nervous	0	2
Respiratory	11	21
Circulatory	0	1
Digestive	12	8
Genito-urinary	2	0
Skin	2	3
Bones and Movements	3	1
Accidental Poisoning	1	0
Peptic Ulcer...	5	4
Total Disease	47	44
No Disease	19	16

TABLE VI

Occupational Histories of Men with Nystagmus before Certification and of Control Group.

(Percentage of man-years in each age group spent in each occupation.)

Occupation	Age Groups											
	15—24		25—34		35—44		45—54		55—65		All Ages	
	Nys.	Cont.	Nys.	Cont.	Nys.	Cont.	Nys.	Cont.	Nys.	Cont.	Nys.	Cont.
Unemployed ...	—	1	1	3	—	—	2	—	—	—	1	1
Outside mining	2	6	1	5	—	—	2	2	—	—	1	4
Forces ...	4	4	2	1	—	—	—	—	—	—	2	2
Surface ...	1	6	1	1	1	—	—	—	—	—	1	3
Haulage ...	37	28	3	—	3	3	—	7	—	—	15	11
Putting ...	32	38	7	10	1	—	—	—	—	—	13	17
Face work ...	24	17	85	80	95	96	96	91	100	100	67	62
Deputy ...	—	—	—	—	—	1	—	—	—	—	—	—
Total Percentage	100	100	100	100	100	100	100	100	100	100	100	100
Total Man-Years	478	423	445	397	299	258	106	106	18	5	1346	1189

"Face work" includes filling tubs or shovelling coal on to a conveyor belt, hewing by hand or pneumatic pick, coal-cutting, and working in stone above or below the coal seam. A "deputy" is a type of underground foreman. For all ages, both nystagmus and control groups spent an equal time unemployed. A smaller proportion of time is spent by the men who eventually get the disease outside mining and on the surface. Time in the armed forces is the same for both groups, and it will be noticed that the men who get nystagmus spend a slightly greater proportion (67 per cent.) of their time at the coal face than do the normals (62 per cent.). In the 15- to 24-year age group, and to a lesser extent also in the 25- to 34-year group, the men with the disease graduate to the coal face a little more quickly than the normals. In short, therefore, the working histories of the men who eventually get nystagmus, so far from being worse than normal, are, if anything, rather better.

TABLE VII

Number of Patients by Length of Unemployment after Certification.

Months	0–6		7–12		13–18		19–24		25–30		31–36		37–42		43–48		49–		Unknown	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Men with Nystagmus	22	46	8	17	5	10	3	6	3	6	1	2	1	2	3	6	1	2	1	2

TABLE VIII

Number of Patients by Each Period of Unemployment up to Twelve Months.

Months	0	1	2	3	4	5	6	7	8	9	10	11	12
Men with Nystagmus	1	2	1	5	1	4	8	1	2	2	0	0	3

The length of unemployment after certification is important from two aspects. It represents a wastage of face workers and is an index of the degree of mental depression. Table VII shows that thirty (63 per cent.) of the men were back at work within a year. The greatest number of these returned to work at the sixth month after certification (Table VIII). 1942, the year of certification, was a time of full employment in the coal industry. When a man was certified as fully disabled he was entitled to draw a basic rate of 35s. per week for six months. At the end of this time

he was re-examined, and, if declared fit (often on the unsound criterion of whether his eyes were oscillating or not), applied to his colliery manager or to the local employment exchange for work. If thought to be unfit, he would be certified again for a further six months. If the patient was not satisfied about the decision, he might appeal to a medical referee. The times of unemployment shown in Tables VII and VIII must, therefore, be related to a number of complicating factors:

(*a*) The natural history of the disease.
(*b*) The labour shortage in the coal field.
(*c*) The low compensation rate in comparison with what could be earned.
(*d*) The certification machinery.

It is reasonable to suppose that during the first six months men were spontaneously recovering and returning to work. At the sixth month eight men (Table VIII) were "signed off" and returned to work, and during the next few months those who felt themselves to be fit gradually drifted back.

TABLE IX

Work to which Men returned after Certification.

Underground		Surface			
		At Colliery		Outside Colliery	
Deputy	1	Labourer ...	11	General labourer ...	4
Hewer	3	Timber yard ...	5	Road work	2
Coal cutter ...	1	Screens	3	Platelayer	1
Stoneman	1	Granary	2	Bricklayer's labourer	1
Timberer	1	Lamp cabin ...	2	Factory hand ...	2
Pump-man ...	1	Girder straightener	1	Pitch and tar work	1
Tub loading at shaft bottom	1	Saw mill	1	Public-house manager	1
		Banksman ...	1		
		"Creeper" ...	1		
Total	9	Total	27	Total	12

The work to which they returned is shown in Table IX. Nine went back to work underground, six were offered work by their own colliery, but three (two hewers and the deputy) obtained work at another pit, and these are also the only underground workers who did not relapse. This suggests, therefore, that about two out of 47 (4 per cent.) of cases of nystagmus may return to, and remain at, the coal face for 5 years in a time of full employment, having had no treatment other than initial removal from the original working environment. Twenty-seven men were offered work by their own colliery, and nearly all undertook either a type of labouring or a light job on the screens, in the lamp cabin, or

controlling the tub elevator or "creeper" motor. Those for whom there was no work at their own pits obtained much the same range of jobs elsewhere. Since only sixteen of these men were symptom free (Table II), it appears that it is quite possible to do useful work—albeit of a labouring type—although recovery from the disease may not be complete. The outlook for return to the coal face without treatment does not seem good, since only small numbers did so, and only a still smaller number of these maintained their working capacity for a period of five years.

Twenty men with nystagmus and 23 controls had avoided any accidents to themselves. All the rest had been involved in at least one accident, with damage ranging from a crushed finger to serious multiple injuries. There was no apparent difference between the two groups in the number or severity of accidents. Twelve men with nystagmus and sixteen controls had witnessed fatal accidents, and a few non-fatal mutilating accidents had been seen in both groups. One man with nystagmus developed symptoms soon after a "bat on the eye", and two others had been involved in accidents a short time before their breakdown. One man had seen an extremely revolting fatal accident three months before certification.

TABLE X

Size of Own Family compared to Size of Father's Family.

Group	Number of Families																					
	No. of Siblings																No. of Children					
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0	1	2	3	4	5	6	7
Nystagmus ...	2	1	3	13	6	5	5	4	3	4	0	0	1	0	0	0	0	7	5	1	4	3	1	2
Controls ...	0	0	2	5	8	9	8	4	5	2	2	1	0	0	0	1	1	6	5	3	3	1	5	0

(c) Social Investigation.

Family Structure.—The number of children in the families of the nystagmus and normal groups, compared with the number of brothers and sisters which their parents had, is shown in Table X. Only the children of families where the mother was 45 or over are considered, the assumption being that by this age no more will be born. The men with nystagmus had an average number of 3·1 children and the control group three. On the

other hand, the men with the disease came from families of an average size of 4·8, whereas the size of the normals' families was greater at 5·8, the odds against this being a chance finding being 100 to 1 (t=2·74, p=0·01). Table X also shows the usual decrease in family size in the present generation. This has affected the families of both groups, but the nystagmus group less because they came from smaller families to start with.

It has been said that coal miners tend to marry women older than themselves, but this is not borne out by this study. The men with nystagmus were, on an average, 2 years 5 months older than their wives, and the normals 1 year 2 months older. There is no significant difference in the childless state of the two groups since there are two single men in each and four childless couples among those with the disease and six among the controls. The only features of note among the causes of death of the parents are that one father committed suicide, and one mother died of "melancholy" at the age of 74—both in the control group.

Early Life.—Thirty-four of the men with nystagmus and 36 of the controls appeared to have had normal and happy home backgrounds. Eight men in the nystagmus group and five of the controls had their home life disturbed by the death of one or both parents in childhood. One man with nystagmus had been adopted in infancy. Five of those with the disease and six of the controls had had other difficulties at home, nearly all due to extreme poverty. Only one man in each group said that his childhood had been unhappy; the one with nystagmus had been brought up by a harsh step-father; the control's father was a drunkard.

There was, thus, no apparent difference between the early home background of the two groups. The impression throughout was that of extreme family solidarity and of capable family management. In all cases where the mother had died leaving young children, some other member of the family—elder sister, grandmother, or aunt—had taken over the maternal duties. Death of the father had usually caused added economic difficulties, sometimes forcing the mother to go out to work herself, but there was no sign that family relationships had suffered. Some degree of poverty was almost universal, but it was only rarely that any serious lack of food or other basic necessities had been felt. The prevailing tendency among the men was to look back on childhood as a happy period in their lives.

Reasons for entering Mining.—Most of these men became miners because they had no choice, but a positive inclination towards some different occupation was commonest among the

controls (Table XI), who included some highly gifted men who might have gone far in other fields.

Intelligence.—There was a wide range of intellectual ability in both groups. The control group contained a rather larger proportion of men who were more literate and had unusual intellectual ability (Table XII). One man with nystagmus had not learnt to read or write until he went into the army, and several in both groups seemed " slow in the up-take ", but all had sufficient native intelligence to deal with their work and home affairs.

TABLE XI

Choice of Occupation.

Group	Preference for Mining	Indifferent	Other Ambitions
Nystagmus	17	18	12
Controls	11	12	24

TABLE XII

Number of Men by Social Background.

Social Factors	Nystagmus				Controls			
	Above average	Average	Below average	Not answered	Above average	Average	Below average	Not answered
Intelligence	5	33	9	—	10	35	2	—
Wife's personality	11	23	9	4*	11	22	8	6†
Household standards	11	29	6	1	11	22	10	3
Housing ...	19	20	8	0	21	14	12	0
Domestic stress	7	16	24	0	7	9	31	0

* 3 single men, 1 widower. †2 single men, 4 widowers.

Housing.—Most of the men had been able to get homes of their own without long delay after they got married, housing

difficulties in the past being due to the poor quality of the houses rather than to their scarcity. There was no apparent difference between the two groups in this respect, and their present housing conditions were also similar (Table XII). Nineteen with nystagmus and 21 controls lived either in council houses or in privately built houses of equivalent or even better standard. These were ranked " above average " in the assessment scale. One man in the control series had built his own house with the aid of a building society.

All the rest lived in colliery houses or in houses of similar type, which had been built by private speculators or bought up from the colliery owners when old pits closed down. Colliery houses were ranked as " average " or " below average ", according to their quality of construction and state of repair. The best were as well built as council houses, sometimes better, but had no bathrooms, and many of the older ones no sinks. There was a cold-water tap in the passage or scullery, and water had to be thrown away down a drain in the yard outside. About a quarter of the families lived in houses which were damp and dilapidated, as well as inconvenient. One or two of the houses in condemned property were stranded amid colliery waste lands, with slag heaps reaching to their very doors, and looked more like decaying shells than habitable homes. There was, however, practically no overcrowding. Household standards were high in both groups, and often superlative.

Wife's Personality. — In general, the atmosphere found in the homes was one of ease and friendliness. In the rough grading that was made (Table XII), the wives who were rated highest were all women of exceptional fibre who had weathered many difficulties themselves, and retained a warmth and serenity of character which might well lend strength to members of the family in sickness or trouble. Some were highly intelligent women, whose social poise would have done them credit in any station of life. The middle or average group were not specially remarkable in any way, but were practical and cheerful women, who took things as they came. Those who were, by comparison, rated " below average ", were sometimes efficient housewives, but their ability to create an atmosphere of calm and confidence was below the general standard. Some of them were obviously over-anxious and easily agitated, and others complained unduly about their difficulties. Very few, however, seemed seriously mal-adjusted, or failed to cope adequately with their household duties. There was no overall difference between the wives of the men with nystagmus and those of the controls.

Domestic Stress.—An approximate comparison of the total amount of domestic stress in the two groups is also shown in Table XII. In the nystagmus group this refers to the home situation up to the time of certification, as subsequent difficulties were mainly a result of the illness. Stress has been classed as "above average" when events had taken place which were likely to have caused serious emotional strain over some length of time. The nature of the event itself was taken as being a more reliable index than the man's apparent subjective reactions. Seven men in each group had been subjected to severe stress according to this reckoning. Three men with nystagmus and four controls had lost their wives—sometimes in tragic circumstances—and had to endure either the anxieties and practical difficulties of a widower with young children, or the loneliness of living on their own. Two men with the disease and one control had suffered on account of the serious or fatal illness of a daughter. One man with nystagmus lived with an overwrought wife and an epileptic stepson in an overcrowded, damp, and rat-infested house. One control, whose housing conditions were not much better, had a wife of low intelligence and an idiot hydrocephalic son of nineteen, who sat rocking himself in a chair in the only living room from morning till night. One man in each group had unusual marital difficulties—the control had separated from his wife. Three men had been certified with nystagmus soon after a severe domestic tragedy.

TABLE XIII

Number of Men by Stability of Character.

Group	Highly Stable	Normally Stable	Unstable
Nystagmus ...	14	22	11
Controls	22	9	16

Patient's Personality.—On the whole, the patients seemed less able, but more stable, than the control group. Here, personal stability was measured by the man's long-term performance at work and in his family life. From the sum total of information, including past industrial, social, and economic history, and home background, and the comments of their wives, it was possible to grade them as in Table XIII.

Neither group contained any seriously unstable men, and they all managed the problems of work and family life adequately. One with nystagmus and one control (who had been converted

from a Communist to a Jehovah's Witness) were eccentric to the point of mild abnormality. The only frankly obsessional man was one of the control group, who suffered from chronic dermatitis, and had kept a note-book for the last 25 years in which he recorded the progress of the disease. The diversity of types in both groups was considerable, and there were no traits by which patients with nystagmus could be recognized. The control group had a larger number of men who combined unusual gifts with great strength and balance of character, and some seven of these would have stood out as leaders of men in any trade or profession. Only three of the men with the disease came near to the same level. On the other hand, the control group also contained a large number of men who were tense or embittered. Twenty-two of those with nystagmus, as against only nine of the controls, were solid straightforward men, with simple tastes and no outstanding characteristics, but eminently sound and sensible. The men with nystagmus seemed, on balance, more "ordinary", and comparison with patients seen in day-to-day clinical work suggests that they were more typical of the rank and file of the local mining community.

Social and Economic Result of Nystagmus.—In 1942, the full rate of compensation, excluding children's allowances, was 35*s.* per week, and this meant only a bare subsistence if incapacity continued over a long period. Often, the rate of compensation was reduced while the man was still unfit to work, or no suitable work was yet available. Some men, who had to stop work on account of nystagmus, were never compensated at the full rate at all; fourteen had severe financial difficulties, and five of these were off work for over two years.

Only four families applied for Public Assistance; the stigma attached to it is so strong that it was resorted to only in the very direst extremity. Sometimes relatives outside the immediate household were able to give some help, and in nine instances the wife went out to work herself to supplement the family income. Many more would have done so if work had been available for them, but the opportunities in their district were very limited. Two of the wives broke down in health as a result of combining the household duties with a full-time job, and some of the others managed it only at severe cost to the general welfare of the family. Sometimes, when a family had managed to subsist on partial compensation without any other supplement to the income, it was difficult to see how it had been done. Only four of the men with nystagmus were now earning as much as they might have expected to had they not been ill, and 26 had their

incomes reduced by 50 per cent. or more. Some were still trying to get permission to return to underground work, but without success.

Compensation difficulties had left little mark on the men, and "compensation neurosis" was only found in one. Compensation had usually been settled fairly quickly, payment often coming through within a few weeks. The somewhat complex machinery of the old act often entailed many visits to different doctors, in both the early and later stages. This was always tiresome, and the fact that compensation rates were based on the amount of oscillation present rather than on the degree of incapacity, was felt to be thoroughly unfair. Compensation was not regarded as an end in itself, but it resulted almost inevitably from a man's admitting incapacity from the disease. Some men had worked for years with miners' nystagmus, knowing quite well what was wrong with them, but deterred from seeking medical advice by fear of losing their jobs. In the past, it was well known among the miners that a man who was known to have had nystagmus stood practically no chance of ever being allowed to work underground again; surface jobs were scarce, and the chances were that he would become totally unemployed. If he lived in a tied colliery house, he was faced with the prospect of losing his home as well as his means of livelihood.

An exceptional demand for labour in the mines at the time when the present series of men were certified greatly eased their resettlement problems, but even so, they often had considerable difficulty in getting back to work. One man, who could not get work at his colliery, was offered a job in a quarry, but was turned down when it was discovered that he had nystagmus. He later succeeded in joining the Navy, and is now a worker in a naphtha plant. Another man tried repeatedly to get work at the colliery and finally managed, with some difficulty, to get passed as fit for work by the medical officer at a munitions factory. In the interim, he had to do the housework while his wife went out to work to support him.

The men with nystagmus had shown initiative and persistence in getting back to work, often in the face of much discouragement from doctors as well as from employers. Where colliery officials had been helpful, this was much appreciated. One man, who was still troubled by attacks of unsteadiness, had been given a job in the lamp room. His symptoms did not interfere with his work there, and the embarrassment which they caused him was minimized by the kindness and consideration of his fellow workers. Where the colliery was unhelpful, the difficulties were much greater. One of the men who is now doing factory work

was passed as fit for work after a year, but was enforcedly idle for another 2½ years. He tried repeatedly at the colliery, and his medical history told against him for other forms of work. In relating the story he expressed no bitterness, but showed clearly how unhappy he had felt, and how welcome help in resettlement or even some slight show of interest would have been. The economic results of the illness were usually worse than the physical ones, but worst of all was the feeling of being waste material of no further use or interest to anyone.

Disease seen through Wife's Eyes. — During the course of the social investigation, comments volunteered by the wives of the men with nystagmus provided some additional clinical information. A most distressing aspect of the illness was the change in temperament which sometimes went with it. Of 37 wives who discussed the effects of the illness sixteen had noticed marked changes during the acute phase; ten wives had noticed some changes, but stressed them less; eleven had noticed physical symptoms only, or no symptoms at all.

The symptom which had seriously worried some of the wives was bad temper, which was specifically mentioned on eighteen occasions, though often it seemed to represent no more than the irritability which may go with any illness. The alternative general change in temperament noticed by the wives was expressed in the phrase, "he went quiet", which implied a general listlessness and loss of interest in outside affairs. Where any general mental change had been noticed by the wives, it could best be summed up either as an increase in tension or as loss of energy. The mental condition improved *pari passu* with the other symptoms of the illness, and its severity did not seem to bear any relation to the man's general stability of character. Depression, when present, seemed no different to that found with any incapacitating illness.

Headache was commented on frequently by the wives, and next in frequency was the movement of the eyes. Several wives noticed particularly that coming into a brightly lit room out of the dark would bring on violent oscillations.

The most troublesome physical symptoms affecting normal life were unsteadiness on stooping, and loss of balance and direction when faced with bright lights. Unsteadiness was sometimes illustrated by the observation that when a man bent down to tie his shoe-laces he fell over forwards. This was mainly an inconvenience as far as the social results were concerned, but the effects of dazzle might be dangerous. Several men had narrowly escaped being run down when the lights of oncoming traffic sent them staggering across the road, and some of them, after five years, still had to be escorted if they went out after dark.

Discussion

After the first world war, there was a tendency to explain coal miners' nystagmus in terms of "shell shock", and Rivers (1922) draws a parallel between the two diseases, and suggests that the disability is psychoneurotic, being largely due to a repressed fear of danger. This view is underlined by Culpin (1925), who asks a question which still remains to be answered, "What sort of man acquires it?" Culpin (1932) describes his findings in 36 cases in a free interview with a brief examination of the eyes, but no control group appears to have been examined in the same way. He groups these cases under the headings of hysteria, anxiety, obsessional state, pathological truculence, and doubtful genuineness; six were normal. In a re-investigation of the psychiatric aspects of the disease, Stern (1948) diagnoses psychological abnormality including malingering, in 43 out of 47 cases; but fifteen of his 23 controls also appeared to be psychologically abnormal.

On the other hand, in the present study conducted upon a small but random sample of cases, more than half the affected men put up with their symptoms for more than a year before becoming certified—and certification in 1942 brought no gain, real or fancied, since the full compensation rate was appreciably below what could be earned by working. The physical differences between the men with the disease and the normal group were very small or absent, and as workmen the men with nystagmus were, if anything, slightly better than normal before breaking down. In hard times they held their jobs as well as the next man, and they were as good as normal both as husbands and as householders. They do, however, differ from the control series in some respects. They came from slightly smaller families, they had smaller families than the usual, and they seemed to be rather less intelligent than the normal group. Owing to the limitations of the method of control, however, these differences may well have been due to the fact that the men who volunteered to be the control group were more intelligent and public-spirited than the usual. But the medical, social, and industrial behaviour of the men with nystagmus in this study does not seem to be that of inadequate individuals, who have a changeable occupational history, who report sick upon slight provocation, and do not put up with disabling symptoms for as long as possible before seeing a doctor.

However, it must not be denied that the syndrome of coal miners' nystagmus contains psychological elements. For example, there is no doubt that at the onset some of these men

are acutely irritable. This appears to subside fairly quickly after removal from the working environment. It is gradually replaced by anxiety, and later by depression, because the administrative machinery and lack of rapid resettlement causes them to be compulsorily unemployed, living upon a pittance. This depression seems to be the depression of unemployment, and in the past of underpayment, rather than the depression of a pre-existing neurosis. It seems clear that the medical assessment of recovery from this disease needs to be made from the symptoms of which the patient complains, and not from the movements of the eyes. After certification and an initial rest of a few weeks, resettlement to standing or sitting work in a good light should be as rapid as possible. Jobs in the dark, or which mean stooping, should be avoided. An attempt, however, should be made to return those whose *symptoms* recover quickly, to coal-face work, provided that their condition is assessed at frequent intervals. This retrospective study shows the great need for further work upon this problem, directed especially towards a follow-up of acute cases.

Summary

(1) A clinical, occupational, and social survey of 47 coal miners certified with nystagmus five years before, has been made, and the results compared with a similar study upon volunteer normal miners of comparable ages and occupations.

(2) More than half the men had symptoms for more than a year before becoming certified. There were four times as many men severely disabled as had gross oscillations of the eyes.

(3) Physically, the two groups were similar in height, weight, and chest expansion. The men with nystagmus had slightly more rapid pulses and higher diastolic blood pressures than did the controls. Occupationally, the men with nystagmus were as good, if not better, workmen than normal. They graduated to the coal face earlier than the normal men and did not suffer more unemployment. Four per cent. of the men with nystagmus ultimately returned to, and remained at, the coal face without specific treatment. The rest found a wide range of work, usually in good light, and not requiring stooping.

(4) The medical and accident histories of the men with nystagmus were not noticeably different from those of the controls.

(5) Socially, the two groups were comparable in respect of personality of wife, household standards, and domestic happiness. The controls were slightly more intelligent, with more outside

interests. Men with nystagmus come from, and have, slightly smaller families than normal.

(6) A diagnosis of gross neurotic predisposition does not seem justified from this study. It is suggested that the nature of the symptoms warrants the anxiety displayed, and the subsequent unemployment and financial hardship, the depression.

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REFERENCES

CULPIN, M. (1925). *British Journal of Ophthalmology*, **9**, 564.

——— (1932). In 3rd Rep. Miners' Nystagmus Comm., *Spec. Rep. Ser. Med. Res. Coun. Lond.*, No. 176.

FERGUSON, W. J. WELLWOOD (1939). "International Lighting Commission Report", p. 246.

——— (1943). *Brit. J. Phys. Med. indust. Hyg.*, **6**, 40.

Lancet (a clinical psychologist) (1940). **1**, 468.

MEIKLEJOHN, A. (1949). *Lancet*, **2**, 360.

RIVERS, W. H. R. (1922). In 1st Rep. Miners' Nystagmus Comm., *Spec. Rep. Ser., Med. Res. Coun. Lond.*, No. 65.

STERN, E. S. (1948). *British Journal of Ophthalmology*, **32**, 209.

WORLD HEALTH ORGANISATION (1948). "International Statistical Classification of Diseases", Vol. I, p. 112.

KERATOGLOBUS AND KERATOCONUS*
A CONTRIBUTION TO THE NOSOLOGICAL INTERPRETATION OF KERATOGLOBUS

BY

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AN interesting work by Verrey (1947) discussing the nature of that very rare deformation of the cornea known as keratoglobus has led me to write about a case I observed many years ago, since I feel that the arguments I was able to deduce therefrom give significant confirmation of the conclusions reached by Verrey.

Previous Opinions

Ophthalmological literature does not agree as to the correct interpretation of the nature of keratoglobus. Less recent authors are generally inclined to identify it with megalocornea and to look upon it as a symptom of arrested hydrophthalmos.

"Keratoglobus, also known as megalocornea, is usually accompanied by infantile hydrophthalmos or glaucoma" (Bietti, 1925).

"There is a form of ectasia of the bulb known as hydrophthalmos, megalophthalmos, or also, because the enlargement of the cornea particularly attracts our attention, as megalocornea or keratoglobus: the affection is congenital or appears shortly after birth without any apparent cause" (Fuchs, 1889).

"Keratoglobus or megalocornea is a partial manifestation of megalophthalmos; usually both keratoglobus and megalophthalmos do not result from an abnormal development though still within physiological limits, but from an increase in tension which, moreover, remains latent, namely a form of hydrophthalmos that has become stationary" (Elschnig, 1923).

Among more recent authors, Prélat (1939) distinguishes keratoglobus from megalocornea proper, identifying the former with buphthalmos:

"When the increase in the diameter of the cornea is regular, it is given the name of megalocornea. This affection may be of two quite distinct types: sometimes it is what is known as essential megalocornea, whereas in other cases the increase in size is apparent in the whole of the eyeball which may be considerably dilated. This deformation, known as keratomegalia, keratoglobus or buphthalmos, is the consequence of iridociliary lesions developing during the intra-uterine period or during the first months of life and is very similar to infantile glaucoma, which is frequently one of the complications of hereditary syphilis".

Duke-Elder (1938), on the other hand, attributes keratoglobus and megalocornea to the same group of deformations, dealing with congenital hydrophthalmos as something apart:

"Megalocornea (keratoglobus, keratomegalia, cornea globosa, anterior megalophthalmos, etc.) is a bilateral developmental anomaly wherein, in the absence of a raised intra-ocular pressure, the anterior segment of the eye is larger than normal".

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Schieck (1931), however, considers keratoglobus as a separate affection erroneously confused with megalocornea:

"Megalocornea is characterized by an increase in the diameter of the corneal disk and is the opposite of microcornea, whereas keratoglobus is characterized by a lessening of the radius of the curvature of the cornea and consequently by an increase in the curving of its surface; its opposite is cornea plana".

According to Schieck, this distinction is not mentioned in the literature, because what has always struck oculists as the essential feature of the foregoing affections is the deepening of the anterior chamber, which is common to both. "For this reason", he concludes, "we find the names megalocornea and keratoglobus used indifferently, side by side, although this use is certainly erroneous".

Verrey's Case

I have reported at some length the contrasting opinions of ancient and modern classical authors regarding the nature of keratoglobus, because these quotations show so clearly that the nosological classification of keratoglobus is still uncertain and confused. In my opinion a good step towards the solution of this question has been made by Verrey, who cites a case of keratoglobus observed in a 23-year-old girl.

Case Report.—The two corneas were quite transparent, very globous and enlarged, with a basic diameter of about 13 mm.; they were also very thin, being about one-third the thickness of a normal cornea. The anterior chamber was very deep. A closer examination of the thickness of the cornea showed that the thinnest part corresponded to an area not far from the limbus, so that the all-round picture was of a pellucid ectasia, representing, so to speak, the reverse of keratoconus in so far as the least resistant part was marginal instead of in the central area of the cornea.

From these traits Verrey concluded that he was dealing in this case with an affection similar to keratoconus, and this opinion was borne out by the fact that he was able at a certain moment to observe in his patient's left eye the appearance of an acute affection of the type described by Pflüger (1876) as acute keratoconus, and consisting, as is known, in a sudden clouding of the cornea due to rupture of Descemet's membrane.

In fact, without any kind of premonitory symptom, the eye in question became irritated and began to water, and there was intense photophobia, the cornea being clouded and very much thickened by the rapid absorption of aqueous humour by the corneal parenchyma. The slit-lamp showed that at the points where the cornea was most seriously affected, the epithelium was detached, Descemet's membrane had lost its normal adherence to the front layers, and the parenchyma showed fissures resembling those to be found in the vitreous in a tumefied cataract. The symptoms came to a climax a few days later and then began to recede, but Verrey was unable to follow the later stages up to the final result.

Verrey concludes that this acute affection, similar to that sometimes observed in keratoconus, is a valuable argument in favour of the thesis that keratoglobus is more similar to keratoconus than to megalocornea. He consequently distinguishes two groups of deformations of the cornea which are apparently similar:

(1) those in which there is simply an increase in the diameter of the cornea and consequently in the front segment of the eye;
(2) those in which there is a change and a lessening in thickness of the corneal parenchyma of mesodermic origin with all the similarities that this suggests from the standpoint of general pathology."

Personal Observations

Many years ago, in the Eye Clinic of Naples University, I was able to observe a typical case of keratoglobus which, in its clinical aspect and the manner of its development, was almost identical with that described by Verrey. In this case also, the marked enlargement of the two corneas was accompanied by a considerable thinning, and an acute affection appeared in the right eye similar to that described above. Further it is interesting to remark that our patient had a son suffering from a typical keratoconus, yet another point in favour of Verrey's opinion concerning the nosological interpretation of keratoglobus.

Case of Keratoconus.—In September, 1932, an 18-year-old student came to the infirmary of the Naples Eye Clinic; he complained of visual failure in both eyes, but particularly in the left; this had started some years ago, progressing gradually until he was now unable to read ordinary print. As a consequence of this weakening of his sight he had been obliged to interrupt his studies a year ago.

The patient was suffering from a typical form of keratoconus in both eyes—but more advanced in the left eye—which had the characteristics of the second type of keratoconus described by Salzmann (1908). The cornea differed from that of the commoner cases in that the cone started from the marginal area near the limbus. The corneal membrane was transparent and very thin. There was no other change in the eye. Vision in the right eye was 1/10 with sph. $-6=$cyl.-5 at 60°; in the left eye it was less than 1/10. There was nothing the matter with the patient's general health. Since it was found impossible to improve his sight with spectacle lenses, contact lenses were prescribed, which were made by Zeiss. Thanks to these contact lenses, which the patient was able to tolerate for many hours a day, he was able to resume his studies.

In 1936 the condition had deteriorated so that the patient no longer benefited from the contact lenses which he had used so far, and as the apex of the cone of the left eye was becoming opaque, we decided to operate. This operation was performed in the Eye Clinic of Rome University, first on the left eye and then on the right, by means of galvanocautery puncture of the most salient portion of the cornea. The patient benefited so much from this operation that he was again able to resume his studies and other activities. The vision in the right eye had risen to 5/10 with sph. $-8=$cyl.$-3{\cdot}50$ at 75°, and the left vision to 2/10 with sph. $-6=$cyl.$-4{\cdot}50$ at 65°.

Subsequently the keratoconus remained stationary in the right eye, the sight of which remains as it was 13 years ago. In the left eye, however, the corneal deformation increased again, and some opaque spots formed around the small operation-leukoma. Keratoplasty was performed this year with excellent results.

Case of Keratoglobus.—Shortly after I first visited this patient, I saw his father who had been suffering from eye trouble since childhood. This man was 54 years old at that time, and a milkman by trade. There was nothing of particular interest in his

past history. He had always enjoyed good health; he had married a healthy woman who had borne him eight children, six boys and two girls; two had died in infancy, but the others were alive and healthy. Apart from the son who was suffering from keratoconus, none of the children appeared to suffer from eye trouble. The wife had never had any miscarriages and had died some years earlier of an acute disease, the exact nature of which had not been ascertained. The patient told me that he had suffered from a deformation of the eyes since childhood, which had never, however, interfered with his occupation. What was worrying him at the time when I saw him was an irritating burning sensation in both eyes. In fact, the patient's eyes were reddened by a flare-up of chronic catarrhal conjunctivitis, but what first attracted notice was the singular appearance of the corneae, which were typical of an advanced keratoglobus.

The corneae were extraordinarily large and prominent: the horizontal diameter at the base was 18 mm.; the anterior chamber was enormously deep. The corneal membrane was quite transparent and very thin, as could be seen from an examination with the slit-lamp, which showed that it was less than half the normal thickness: there did not appear to be any marked differences in thickness between one region of the cornea and another. Near the limbus there were neither opacities nor vascular loops. The iris presented a normal aspect and the refractive media were transparent. There was nothing particular about the fundus: the optic disk was pink and not cupped. The intra-ocular pressure was normal, vision could not be ascertained because of the patient's backward mental development but was approximately 4/10 in both eyes, with the aid of correcting-lenses for slight myopic astigmatism. The visual field was full.

An argyrol collyrium was prescribed, and the patient was not seen again for a number of years. In May, 1935, he returned, complaining that two days before, for no particular reason, the sight of his right eye had suddenly failed.

Examination showed moderate circumcorneal injection, together with loss of corneal transparency. Photophobia and lacrimation were also noted. The corneal membrane presented a cloudy and thickened appearance by reason of sudden spontaneous imbibition, such as often occurs in keratoconus: this condition was particularly evident axially and above, where the opacity was milky and deep with indistinct outlines. Examination with the slit-lamp showed that the thickness of the parenchyma in the most seriously affected region was very great, the epithelium was bedewed by oedema; no details of Descemet's membrane were to be perceived. The eyeball was slightly hypotonic, and the cornea somewhat flattened. Vision was reduced to finger-counting, while the visual field remained normal. No change was found in the other eye.

Atropine and dionin drops were prescribed as well as hot damp compresses. Eight days later there was already appreciable improvement, the cornea had grown clearer and the reactive conditions were making progress.

Recently I had news of this patient who is now 71 years old; as he cannot leave his home, which is very far away from Rome, owing to his age and the rheumatism that has been crippling him for some years, he was visited by a colleague. This visit in the patient's home gave the following results:

Senile spastic entropion of the lower lid and chronic conjunctivitis in both eyes. *Right eye:* Enormously enlarged and bulging cornea, three-quarters opaque; folds in Descemet's membrane still evident. Horizontal diameter 17 mm. Depth

of anterior chamber greatly increased. Opacity of the crystalline lens. Vision= under 1/10. Ocular tonus and visual field normal.

Left eye: Enormously enlarged and bulging cornea of normal transparency. Diameter 18 mm. Depth of anterior chamber greatly increased. Central opacities of the crystalline lens. Normal fundus. Vision = 1/30. It was not possible to attempt a correction with spectacles.

This then is the case of a patient who has been suffering since childhood from an eye affection so typical of keratoglobus that as Verrey says, referring to his own case:

"If the expression keratoglobus did not exist, it would have to be invented, so suited is it to the corneal deformation of our patient. The clinical picture, in fact, was that of a pellucid ectasia of the two corneae, which were enormously enlarged and globous: they were less than half the normal thickness and the anterior chamber was exceptionally deep. The endocular tonus, the fundus of the eye and the visual field were normal".

In our case, as in Verrey's, there was an acute imbibition of the corneal parenchyma in one eye at a certain moment, due to rupture of Descemet's membrane, such as frequently occurs in keratoconus. This acute imbibition is often found in keratoconus and, though it is not frequent, we have observed it several times in our clinic and attention has recently been drawn to it by Amsler (1940).

The fact that this condition occurred in our patient and that there was a marked curvature and thinness of the cornea go to prove the affinity between keratoglobus and keratoconus.

Another point of considerable importance illustrated by our case, is the fact that one of our patient's sons suffered from keratoconus and had to undergo several operations. Unfortunately we were not able to carry out further genealogical researches which would undoubtedly have proved most interesting.

I feel that the foregoing observations help considerably to clear up the problem of the nosological interpretation of keratoglobus. This extremely rare deformation of the cornea deserves to be classified as a distinct affection with well-defined characteristics, and its name should only be used to indicate a pellucid ectasia of both corneas, with an exceptional enlargement and curvature of the corneal membrane, and a marked thinning of the parenchyma. These features of the affection and the possibility of an acute phase of clouding of the cornea due to rupture of Descemet's membrane during the course of the disease, as well as hereditary transmission in the form of keratoconus, prove that there is a close relationship between keratoglobus and keratoconus. Consequently keratoglobus must not be confused, as it has been so far by the vast majority of authors, either with megalocornea, which is characterized by an increase in the basic diameter of the cornea and consequently of the front segment of the eye (it is therefore a sign of anterior megalophthalmos),

or with arrested hydrophthalmos, since in keratoglobus we do not find a total increase in the size of the eye-ball, or increased tension, or cupping of the disk, or an advance of the limbus over the cornea, as has been pointed out by Schieck (1931).

Summary

(1) Having established that opinions still differ widely concerning the nature of the rare deformation of the cornea known as keratoglobus, a case is described that should help in establishing its exact nature.

(2) Both corneae of the patient in question were enormously enlarged and globous, and the anterior chamber was exceptionally deep, the corneae being less than half the normal thickness. At a certain moment an acute imbibition of the cornea occurred in one eye as a result of rupture of Descemet's membrane, such as sometimes occurs in keratoconus. One of the patient's sons suffered from keratoconus.

(3) The clinical features observed are very similar to those seen in Verrey's recent case.

(4) The conclusion is reached that keratoglobus is a distinct affection with well defined characteristics (great enlargement and curvature of the cornea, marked thinning of the parenchyma), and closely connected with keratoconus. Consequently it must not be confused with megalocornea or with arrested hydrophthalmos as it has been hitherto by the majority of authors.

REFERENCES

AMSLER, M. (1946). *Bull. Soc. franç. Ophtal.*, **59**, 120.

BIETTI, A. (1925). "Trattato di Oftalmojatria", vol. I, p. 503. 1st. Edit. Scient., Milan.

DUKE-ELDER, S. (1938). "Text-book of Ophthalmology", vol. 2, p. 1277. Kimpton, London.

ELSCHNIG, A. (1923). In Axenfeld T., "Lehrbuch und Atlas der Augenheilkunde", 7th ed., p. 398. Fischer, Jena.

FUCHS, E. (1st ed. 1889). "Lehrbuch der Augenheilkunde", 1922, p. 421. Deuticke, Leipzig.

PFLÜGER. Cited by Verrey.

PRÉLAT, P. (1939). In "Traité d'Ophtalmologie", ed. P. Bailliart and others, **4**, p, 669. Masson, Paris.

SALZMANN, M. (1908). *Graefes Arch. Ophthal.*, **67**, 1.

SCHIECK, F. (1931). In Schieck, F., and Bruckner, A. "Kurzes Handbuch der Ophthalmologie", vol. 4, p. 237. Springer, Berlin.

VERREY, F. (1947). *Ophthalmologica, Basel*, **114**, 284.

AUREOMYCIN IN TRACHOMA*

BY

A. J. BOASE

Uganda

IN an earlier communication (Boase, 1950) it was suggested that aureomycin (Lederle) drops were very effective in the treatment of trachoma. That opinion was based on a small number of cases, none of whom has reappeared with a relapse. The present report deals with 36 cases, the last four included being at a disadvantage as the supply of aureomycin gave out after only three days' treatment. Twenty cases received drops only, ten received drops and oral capsules, and six oral capsules only. The drops, made up by dissolving the powder in distilled water, were administered at intervals varying from one to four hours. There were no complaints of irritation (Ainslie, 1950). It was found that 2-hourly intervals were the most convenient for the nursing staff, allowing four or five instillations a day. No treatment was given at night. Capsules were given three times a day in eleven cases, and five times a day in five cases. With the exception of four Asiatics, the patients were natives of Uganda and were treated in hospital, the longest in-patient stay being 22 days and the shortest four days. In four cases (20, 21, 23, and 25) treatment was curtailed in favour of a bilateral tarsectomy. The chief particulars are tabulated overleaf; four cases (7, 11, 17, and 20) are given in detail.

Case Histories in Detail

Case 7.—(No. 582) Male, aged 41. Admitted January 25, 1950. Photophobia and lacrimation for one month. Fine papillary hypertrophy and many follicles. Early active pannus. Aureomycin drops 2-hourly. February 1, symptom-free, no macroscopic evidence of trachoma, says he is cured and asks discharge. Total days treated 7. Assessment on discharge—cured.

Case 11.—Asiatic female, aged 18. First seen in November, 1949, with the complaint that her eyes had been sore for some time, and that the left had been very bad for three weeks. She had had much treatment from different doctors. Left eye showed a thick succulent ¼ pannus with a trachomatous ulcer at its edge, many follicles and fine papillary hypertrophy. Right eye was fairly quiet with few follicles and ⅛ micro-pannus. I treated her regularly with paintings of albucid, twice with silver nitrate, and a course of sulphadiazine. The left eye was atropinized. She ceased attending after one month and was not seen again until January 30 when she said she had been to Nairobi and had been treated there. She was now markedly photophobic and the left eye had a pronounced droop. The ulcer had recurred and was much larger than in November (it had not entirely ceased to stain under my earlier treatment). Pannus had extended and was now about ½. There were confluent blebs on the transition fold. Right eye showed little change. She was given a 5 ml. bottle of aureomycin and told to use the drops "frequently." A message on February 1 informed me that she

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TABLE

Chief Particulars of 36 Cases of Trachoma treated with Aureomycin.

Case No.	Sex	Age	Length of History	Treatment			Assessment on Discharge
				Method	Dosage	Duration (days)	
1	♀	30	1 year+R.L.	D	hourly	20	improved
2	♂	45	R. 1 month L. normal	D	hourly	12	improved
3	♀	9	vague but long	D	hourly	22	improved
4	♂	32	1 month	D	hourly atropine to R.	12	improved
5	♀	8	2 years	D	hourly	19	cured
6	♂	10	long	D	2-hourly	7	improved
7	♂	41	1 month	D	2-hourly	7	cured
8	♂	30	2 weeks	D	2-hourly	12	cured
9	♂	23	5 months	D	3-hourly atropine to L.	7	improved
10	♂	48	2 weeks	S	3 times daily no local treatment	7	cured
11	♀	18	3 months	D	" frequent " (out-patient treatment)	15	cured
12	♂	25	5 months	D S	3-hourly 3 times daily	7	improved
13	♂	35	10 years	D	3-hourly	12	improved
14	♂	30	7 years	D S	3 times daily 3 times daily	5	improved
15	♂	13	8 months	D S	3-hourly 3 times daily	12	cured
16	♀	4½	L. 1 year R. normal	D	3-hourly	14	cured
17	♂	30	3 weeks	D	4-hourly	7	cured
18	♂	17	1 year	D S	3-hourly 3 times daily	7	improved
19	♀	12	long	D	2-hourly	8	improved
20	♂	35	1 year +	D	2-hourly bilateral tarsectomy	8	no change

TABLE—*continued*

Case No.	Sex	Age	Length of History	Treatment			Assessment on Discharge
				Method	Dosage	Duration (days)	
21	♂	60	long	D bi	2-hourly atropine 3 times daily lateral tarsecto	8 my	improved
22	♀	20	acute	S	5 times daily	7	cured
23	♀	43	10 years	S D bi	5 times daily 2-hourly lateral tarsecto	3 3+ my	improved
24	♀	50	long	S	5 times daily no local treatment	5	improved
25	♂	15	long	S ta	5 times daily rsectomy later	5	improved
26	♀	7	1 year –	D	2-hourly	17	improved
27	♀	11	3 years	S D	3 times daily 2-hourly	7 5	improved
28	♀	14	2 years	S D	3 times daily 2-hourly	4 5	improved
29	♀	4	2 years	D	2-hourly	7	improved
30	♀	33	2 weeks	S D	3 times daily 2-hourly	7	improved
31	♀	8	6 months	D	frequent	15	doubtful improvement
32	♀	16	1 week	D	2-hourly	5	improved
33*	♂	20	2 years	D	2-hourly	3	improved
34*	♂	32	2 years	D	2-hourly	3	no change
35*	♂	7	1 month	S	3 times daily	5	improved
36*	♂	36	acute	S	3 times daily (2 capsules)	5	not improved

D=drops. S=systemic : the amount of aureomycin given was one capsule per dose, except where otherwise indicated.

* In Cases 33 to 36 the available supply of aureomycin ran out so that treatment could not be completed.

was much better; on February 6 she was smiling, happy, and symptom-free. The left eye is white, the ulcer does not stain, the pannus is definitely regressing. Follicles are not seen, there are still some small blebs on left transition fold. She was given a second bottle of aureomycin, and on February 14 said she was cured. Apart from a slight droop of the left upper lid and attenuated pannus there are no signs of trachoma.

Total days treated, 15. Assessment on discharge—cured.

Note: Since it is said that aureomycin loses its potency after 48 hours the period of effective treatment in this case is only four days.

Case 17.—(No. 1120) Male, aged 30. Admitted February 20 with three weeks' history of intense photophobia and profuse lacrimation, has to be led by a friend. Upper tarsi crowded with follicles, rich succulent ½ pannus. Aureomycin *capsules, one* three times daily, drops 4-hourly.

February 22, eyes open, says he has no discomfort.

February 24, says he is cured and wants to go. Capsules stopped. February 27, *lids perfectly normal, pannus* attenuated to a mere fringe of vessels seen with difficulty with the slit-lamp.

Total days treated, 7. Assessment on discharge—Cured.

Case 20.—(No. 1261) Male, aged 35. Admitted February 27, 1950. History over one year. Marked ptosis, gross papillary hypertrophy with a network of pigment and early Arlt scarring. Total macro-pannus with large vessels from all sides. Aureomycin drops 2-hourly. March 6, thinks he is a little better but is not enthusiastic. Objectively, the papillary hypertrophy appears less gross but otherwise there is no real change. Treatment was stopped and a bilateral tarsectomy performed.

Inclusion Bodies.—The finding of inclusion bodies may be indispensable for diagnosis where this is in doubt, but in a country so heavily infected as Uganda it has only an academic interest, and to make it a *sine qua non* for diagnosis is comparable to insisting on recognition of the spirochaete before embarking on an anti-yaws campaign. In this series conjunctival scrapings were examined in practically all the cases before treatment, but since in a one-man team the time factor is relentless the scrutiny given was hardly sufficient to say with confidence that inclusion bodies were absent. The most that can be said is that they were not found after inadequate search. The positive cases are ascribed more to early good luck than to diligent perseverance.

Excised Tarsal Plates.—The histopathology is typically that of trachoma. In all the specimens there is a profusion of mast cells.

Case 20.—Deep epithelial penetration with large lacunar formations. Marked infiltration, plasma cells predominating, follicular grouping in parts. Much fibrous tissue permeates the mucosa; it is difficult to distinguish the transition from the tarsus which is itself infiltrated with many spindle-shaped cells.

Case 21.—The infiltrated mucosa is thick, about half the thickness of the tarsus from which it is clearly demarcated, though here and there strands of fibrous tissue lead through to the surface. The tarsus is very clean with practically no infiltration; the Meibomian glands are distinct. Deep lacunar penetration of the epithelium reaching in places to the tarsus, surface cells flattened and eroded in parts. Fine pigment granules are seen among the surface cells and accompanying the inward proliferations in a spidery manner. There are no classical follicles. The infiltration shows a preponderance of plasma cells.

Case 23.—The epithelium is thin and flattened with blunt club-shaped inward penetration while some columns go deeper to form lacunae or pseudo-glands. Meibomian glands very distorted and in parts obliterated. No classical follicles. Plasma cells predominate in the infiltration. Despite the clinical findings there is nothing to distinguish the two specimens.

Case 25.—In one tarsus the mucosa is very thin, in the other it is much thicker. Surface cells are flattened. Infiltration is moderate and is permeated by fibroblasts and fibrous tissue. No classical follicles. Capillaries dilated. Meibomian glands very clear.

Discussion

The most striking effect of treatment with aureomycin is the rapid relief of the subjective symptoms of lacrimation and photophobia. If it did nothing else the drug would earn an undisputed place in the armamentarium of the trachomatologist.

But does it cure trachoma? What do we mean by a "cure"? In a disease of such remorseless endurance the criterion of this is difficult to assess. Every trachomatologist of experience must surely have had not a few of his "cured" cases return in later years for the relief of trichiasis. Yet the stimulus to form scar tissue presumably lies in persistence of the noxious influence, for Nature as a rule is not prodigal in repair; who knows but that the common keloid will one day admit an aetiology at present undreamt of? Nevertheless it is generally accepted that in the absence of other signs of activity a smooth tarsus indicates freedom from infectivity, at least from a public health point of view.

By this standard nine of the cases in this series are passed as cured. Of the remainder the majority showed a marked improvement. There is some evidence (10, 15, 16, 32, 35) that resolution progresses after cessation of treatment. It is therefore not improbable that some of those classified as improved might later be put into the category of the cured. Unfortunately native patients do not re-attend without a special reason, which is usually persistence of symptoms. Case 10 is an example; this man would certainly not have returned had his wife not become ill. Yet although on discharge he was only considered improved, three weeks later a fortuitous examination found him cured.

From the histological aspect there is little evidence in the excised tarsi to suggest that aureomycin treatment is likely to lead to a rapid reversal in the tissue changes. Nor should this be expected, for from their nature it would seem that time alone could effect a *restitutio ad integram*. Furthermore, of the cases thus examined none had progressed far towards the standard of clinical cure accepted above. In this connection it is of interest to record the pathologist's report on Case 3 of my original series (Boase, 1950), for which I am indebted to Dr. Norman Ashton, Director of the Department of Pathology, Institute of Ophthalmology, London:

> Sections show rather thickened tarsal plates which, on the conjunctival surface, show dense infiltration with round cells and plasma cells of the adenoidal layer of the conjunctiva. Typical follicles are present in the specimen taken from the right eye. Pseudo-glandular formation is present in all sections. No inclusion bodies have been found in the epithelial cells. The only effect which histological examination might attribute to the treatment given is the lack of infiltration in the epithelial surface itself which looks unusually "clean" in some areas.

It remains to be added that the four specimens of the present

series were examined for me by Dr. E. S. Horgan, Director of the Virus Research Institute, Uganda, who has kindly informed me that he could find no inclusion bodies.

Conclusion

Whether or not aureomycin actually cures trachoma, I am satisfied that it does produce a dramatic ameliorative effect the like of which I have not seen before with any other treatment in a long experience of trachoma in a particularly virulent form. My experience with the sulphonamides has been disappointing; they give improvement up to a point but never a cure. Penicillin is useless except as an adjuvant. But the full benefit of aureomycin is best appreciated in contrast with the older classical treatments:

Under vigorous daily treatment by mechanical means, followed by the daily application of various drugs, most ordinary cases of Tr. IIa can be converted into the stage Tr. III in about fifteen days (MacCallan, 1936).

The copper sulphate treatment should be continued daily until the disease has been completely cured. This may take from one to six years or more (Lindner, 1936).

The disease finally subsided after some months of energetic mechanical treatment (Loewenstein, 1945, writing of two cases under observation from their inception).

What patient would not prefer to use some innocuous drops, even, if necessary, for "one to six years or more"?

Postscript After the foregoing case reports were written I saw Case 8 again, on April 24. A schoolmaster from an outlying rural school, he had come to Kampala for a conference. He told me that his eyes had been quite well until about a week ago when they had started to smart and itch. This was annoying but in no way incapacitating, and he was sure it was quite different from the trouble of three months ago. Examination showed a mild catarrhal conjunctivitis with slight sticky mucoid secretion, but the moderately injected tarsi showed a few unquestionable very small follicles. The slit-lamp revealed only a few attenuated vessels, certainly no active pannus.

I feel that these follicles must be regarded as evidence of active trachoma, but whether this is a relapse or a fresh infection I cannot say. Would symptoms of a relapse not have occurred earlier than three months after an apparent cure? His environment is in favour of a fresh infection, for in any rural school in Uganda one expects to find a fair proportion of infected children.

REFERENCES

BOASE, A. J. (1950). *British Journal of Ophthalmology*, **34**, 35.

AINSLIE, D. (1950). *Ibid.*, **34**, 41.

MACCALLAN, A. F. (1936). "Trachoma", p. 17. Butterworth.

LINDNER, K. (1936). *In* Berens, C., "The Eye and its Diseases", p. 433. Saunders, Philadelphia.

LOEWENSTEIN, A. (1945). *Amer. J. Ophthal.*, **28**, 282.

A CASE OF LEIOMYOMA OF THE IRIS*

BY

A. STANWORTH

Manchester

LEIOMYOMATA of the iris are rare tumours, only eight or nine having been reported. Most of these were diagnosed clinically as sarcomata, the true diagnosis being made only on histological examination; so far as I am aware the present case is the first in which the presumptive diagnosis was made on clinical grounds alone.

Case Report

The patient, a lady aged 58 years, attended the Manchester Royal Eye Hospital on January 11, 1950, having experienced a sudden loss of vision in the left eye after stooping the previous day. The only relevant history was a fall 2½ years before, as a result of which she had been cut around the eyes, without any definite ocular injury. On examination, the right eye was normal, the corrected vision being 6/9. The left vision was counting fingers only. There was a hyphaema extending over the lower half of the iris and pupillary area, obscuring a swelling projecting forwards from the lower quandrant of the iris. The next day the hyphaema was much smaller and her corrected vision was 6/6 partly. She was admitted for investigation under Dr. W. Stirling.

FIG. 1.—General appearance of iris swelling in left eye.

The iris tumour was situated in the lower nasal quadrant (Fig. 1). It appeared to arise from the middle third of the iris, the apex being free of the pupil, though projecting over it; the peripheral margin of the iris was also clear of the tumour. The swelling had a lightly pigmented irregular surface, with a few large superficial blood vessels which were presumably the source of the hyphaema. The remainder of the iris was normal, and no exudates or keratic precipitates were seen. The pupil dilated quite well, but not fully, with homatropine and cocaine; it was thought that the failure to dilate fully was due to the mechanical effect of the swelling rather than to an invasive character of the tumour. In the sector of the lens immediately behind the swelling there was an anterior lens opacity, the remainder of the lens being clear. Accommodation was normal and equal in both eyes; the fundi and ocular tension was normal and the fields full. Transillumination was negative, and the swelling was not translucent. The Wassermann reaction was negative.

* Received for publication May 19, 1950.

The diagnosis of "benign tumour, probably leiomyoma" was made. On February 10, 1950, Dr. Stirling performed an iridectomy, the tumour being completely removed, together with the surrounding iris. Apart from an operative hyphaema, which cleared rapidly, convalescence was uneventful. The lens opacity was now seen to be largely subcapsular, with striae running into the anterior layers of the cortex.

Pathological Report.—The specimen was examined by Dr. J. Wainwright, who reported as follows:

Histology of Tumour of the Iris.—There is a small tumour about 2 mm. in length on the anterior surface of the iris, which appears to arise from the smooth muscular fibres lying beneath the pigment layers. It consists of interwoven bundles of smooth muscle fibres, some of which are cut longitudinally, others transversely. The cells are of spindle type with uniform rod-shaped nuclei. No mitoses are present. The cytoplasm is stained yellow with van Geison, but it is not possible to demonstrate myofibrils with Mallory's phosphotungstic acid haematoxylin. In the deeper part of the tumour the muscle bundles are separated by remains of the collagenous stroma of the iris, but in the superficial parts there are no fibrils staining pink with van Geison stain. Pigment granules are included in the deeper part of the tumour, but are not seen within spindle cells. The appearances are those of leiomyoma of the iris. The failure to show myofibrils is not significant since these are not invariably found in leiomyoma arising in other regions of the body.

The microscopic appearances are shown in Figs. 2 and 3.

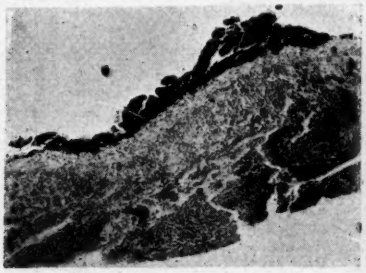


FIG. 2.—Histology of tumour. Haematoxylin and Eosin. ×35.

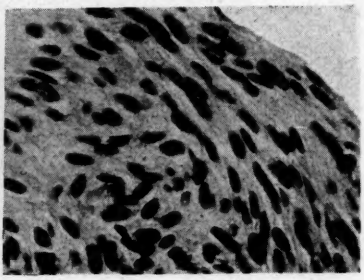


FIG. 3.—Histology of tumour. Van Gieson. ×300.

Discussion

The literature on leiomyoma of the iris has recently been summarized by Fleming (1948) and O'Day (1949), each of whom report an additional case. The points on which a clinical diagnosis of leiomyoma was made in the present case were:

(1) The total absence of inflammatory signs.
(2) The absence of any invasive characteristics of the tumour such as a marked interference with pupillary reactions or extension to the angle of the anterior chamber.
(3) The presence of hyphaema, which has been described in many of the reported cases (Van Duyse, 1911; Verhoeff, 1923; Ellett, 1939; O'Day, 1949).

(4) The site, as in all previous cases, in the lower half of the iris.
(5) The presence of a cataract localized to the area behind the swelling; this was taken to indicate that the swelling had probably been present for some time. A cataract was present behind the tumour in the patients described by Ellett (1939) and O'Day (1949).
(6) The absence of gross pigmentation. In general the published descriptions of leiomyomata show the tumours to be about the same colour as the iris, though one (Frost, 1936) is described as being dotted with pigment, and two others as becoming gradually darker (Ellett, 1939; Fleming, 1948), the latter being diagnosed originally as a malignant melanoma.

It was, of course, impossible to be certain that the condition was not a sarcoma of the iris, as all the above criteria, with the possible exception of the cataract, may well be present in an early sarcoma. Nevertheless, sarcomata are prone to invade the angle of the anterior chamber early and are commonly more pigmented than was the present tumour. It seems justifiable, therefore, to consider any tumour satisfying the above criteria as a probable leiomyoma, and to treat it by iridectomy.

Summary

Clinical and histological details are reported of a leiomyoma of the iris, and the typical features which enabled a clinical diagnosis to be made are discussed.

I wish to thank Dr. W. Stirling for permission to report this case, and Dr. J. Wainwright for the pathological report.

REFERENCES

ELLETT, E. C. (1939). *Arch. Ophthal. Chicago*, **21**, 497.
FLEMING, N. (1948). *British Journal of Ophthalmology*, **32**, 885.
FROST, A. D. (1936). *Arch. Ophthal., Chicago*, **16**, 892.
O'DAY, K. (1949). *British Journal of Ophthalmology*, **33**, 283.
VAN DUYSE. (1911). *Arch. Ophtal., Paris*, **31**, 13.
VERHOEFF, F. H. (1923). *Arch. Ophthal., Chicago*, **52**, 132.

APPLIANCES

OPERATING SPECTACLES*

BY

H. B. STALLARD

London

THE requisites of operating spectacles are:

(1) The absence or the minimum of any obstruction to the operator's field of view,
(2) a remoteness of the sphero-prisms from his eyes to avoid steaming of the lenses,
(3) a hinged frame carrying the glasses which may be quickly pushed up out of the line of vision when necessary,
(4) a light frame with the minimum of pressure on the nose and ears.

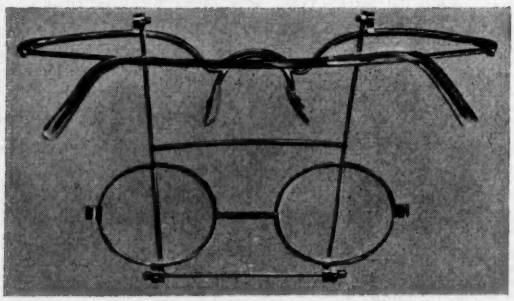


FIG. 1.

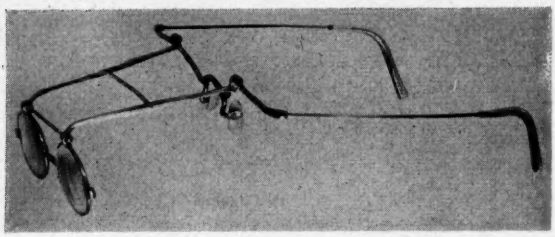


FIG. 2.

Figs. 1 and 2 show a pair of spectacles made by Theodore Hamblin which meet these needs. When the extension carrying the lenses is swung upwards in front of the forehead there is no obstruction below or to the sides of the operator's field of view. The frames are very light and comfortable. The lenses never

* Received for publication March 10, 1950.

become steamed over for they are placed well in front of the operator's nose and the plane of his mask.

Hinges are present, (1) where the lens-bearing frame joins the struts carried forward from the face-frame, (2) where the struts join the face-frame, (3) at the junction of the side-pieces with the face-frame.

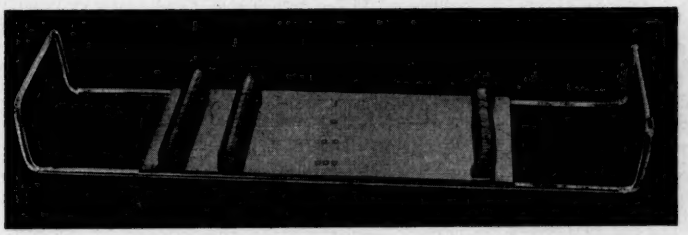
A RACK FOR OPHTHALMIC NEEDLES AND SUTURES*

BY

H. B. STALLARD

London

THE Figure shows a rack for holding ophthalmic needles and sutures. Its purpose is to keep these in appropriate order so that they may be picked up quickly in a needle-holder. This device consists of a plate subdivided by parallel grooves, the intervening spaces marked for No. 1, 0, 00, and 000 sutures. Attached to the plate by screws are three wire coils. The intermediate coil is set 2·5 cm. from one of the end coils, in which is placed the needle. The long arm and the short arm of the suture are engaged in



FIGURE

the intermediate coil and the long arm is carried on to the third coil. The needle and the suture lie in line within the appropriate subdivision.

The looped frame projecting beyond the end of the plate is to facilitate lifting the rack out of the sterilizer with double hooks.

The advantages of this rack are these:

(1) the needles and sutures are easily identified,

(2) they are readily picked up with a needle-holder either by the surgeon or by the nurse in charge of instruments,

(3) the suture is free from flecks of lint which often cling to silk which is sterilized in a lint roll.

* Received for publication March 10, 1950.

BOOK NOTICES

Recent Advances in the Physiology of Vision. By H. HARTRIDGE. 1950. Pp. 401, 236 figs. J. and A. Churchill, London. 25*s*.

In spite of the author's contention in the first sentence of the preface, it is doubtful whether this is, in reality, the best moment for the appearance of a book on the recent advances in the physiology of vision. It is true that the last fifteen years have witnessed a great increase in our knowledge of two important branches of the subject and that this advance has been largely due to the systematic application of objective rather than sensory methods. We refer, of course, to the work, mainly of Granit and his colleagues, on the electrical changes set up in the retina and optic nerve fibres by light stimulation, and to the investigations of the properties of visual pigments, especially of visual purple, carried out by Lythgoe and his collaborators in Great Britain and by Wald in America. But, with the exception of his results on the effect of polarization (and the explanation of these is by no means clear as yet), Granit's work has already been well summarized in his book published in 1947 which also contains an admirable account of the position with regard to visual purple at that date. Neither of these two subjects is dealt with fully in Professor Hartridge's book.

It is certainly true that two of the bastions of visual theory (the duplicity theory and the trichromatic theory of colour vision) are being vigorously assailed at the present time, but it is not at all certain that, when the dust and turmoil of battle have settled, both will not be found to stand as firmly as ever. At the moment, however, it is hardly possible (to change the metaphor) to see the wood for the trees and it is therefore extremely difficult to form a balanced picture.

Unfortunately, the book shows signs of insufficient thought and care in its preparation. Thus, a discussion of the effect of illumination on visual acuity is separated from the main section on this subject by some 250 pages; and the consideration of colour vision and colour defects, mainly dealt with in Chapters 4 and 5, appears again in Chapter 8, with sections on the effect of illumination on visual acuity and the interrelation of area and intensity of stimulation. There are also several statements which are extremely damaging to arguments presented in other parts of the book. For instance, the effect of altering the area of stimulation on the light threshold is probably due to the necessity for the cortical reception of a given number of impulses in a given time before a sensation can be produced. An explanation on these lines is offered in Section 62.

and the probability that the same process also applies in the perception of colour is suggested as an explanation of the lack of appreciation of the coloured fringes due to chromatic aberration; but the fact that the same explanation could equally well be applied to the effect of decreasing the area or lowering the intensity of a coloured stimulus is entirely ignored. It could explain most of the phenomena for which the author invokes his antichromatic reflex.

Some mistakes should be mentioned. Section 20 on the electroretinogram is misleading since Granit's division of electroretinograms into an E- or an I-type was not put forward until the 1930s, twenty years after the papers by Einthoven and Jolly (1908) and Piper (1911). It is not the E-retina but the I-retina which exhibits large and active *a*-waves linked with inhibition and an off-effect. The E-electroretinogram has so far been found in mammals only and is associated not with cones but with rods. The off-effect is produced by a combination of PII and PIII and does not appear in the absence of PIII. There is no rise of PII at "off" but since it disappears more slowly than PIII there is an increase in positivity. There is no evidence that PII "represents the sum total of a number of processes with different latent periods". It is PII and not PIII which resembles the potentials in such an eye as that of *Limulus* where the fibre from the receptor can be tapped before the intervention of the first synapse. Misprints also occur in the spelling of names and in numerals (*e.g.*, 0.80μ for 0.080μ on p. 255, and 5,893mμ for 589.3mμ on p. 326).

Principles of Ophthalmology. By THOMSON HENDERSON. 1950. Pp. 230, 63 figures, 19 plates. William Heinemann, London. 20*s*.

The first part of this book is concerned with the comparative anatomy of the mammalian globe. There is evidence of industry and patience on the part of the author, who has investigated in many animals the exact site of the extra-ocular muscle insertions, the size of the corneal and global diameters, and the asymmetry of the ciliary region. The presence of a circumlental space and of a dilator pupillæ has also received meticulous attention.

The remainder consists in a consideration of anatomical, physiological, and pathological problems in ophthalmology: the function of the angle of the anterior chamber, the mechanism of accommodation, the significance and nature of intra-ocular pressure, the ætiology of glaucoma, and the process of healing in corneo-scleral wounds are some of the subjects discussed.

It is common knowledge that a wealth of thought and experiment has been expended in the past by many devoted and talented workers on these very problems and to-day they are under active

consideration in all parts of the ophthalmological world. It is a healthy sign that there is no unanimity of opinion regarding their solution, even though the proof or disproof of a hypothesis concerning any one of them may defy a life's work.

The author of " Principles of Ophthalmology " appears, however, to have solved the whole series to his own satisfaction. Thus he tells us that the pressure on the retina must be equilibrated, and proposes a circulation of intra-ocular fluid from the angle of the anterior chamber to the suprachoroidal space; glaucoma is stated to be a result of physiological sclerosis of the cribriform ligament and of the interstitial tissue of the ciliary muscle; the lens fibres are held to be enclosed in their capsule under stress and manifest elasticity; myopia is defined as scleral rickets, influenced by heredity to the same degree as is flat-foot. These and many other ideas are none the worse for being unorthodox and sometimes original, but one wonders whether they will stand the test of past and future research. The author answers this question in the epilogue:

> In the light of further knowledge it is quite possible that some of the views that have been expressed in the course of this work may require revision.

In an aggressively written book this is the only understatement and the only one to which the reviewer can subscribe without hesitation.

Documenta Ophthalmologica, Vol. IV. Edited by F. P. FISCHER, A. J. SCHAEFFER, and A. SORSBY, 1950. Publisher: Dr. W. Junk, The Hague. 67*s.* 11*d.*

The fourth volume of *Documenta Ophthalmologica*, treating of recent advances in ophthalmology, which has now appeared, is as useful as its three excellent predecessors. The book contains a short complimentary introduction addressed to K. Wessely, the senior member of the editorial committee, on the occasion of his 75th birthday, with a full bibliography of his writings. There is an obituary notice of F. P. Fischer of Utrecht who did so much in the past as editor. The following is a list of the scientific articles, abstracts of which will appear in *Ophthalmic Literature*:

Quanta Explanation of Vision, M. A. Bouman.

Visual Purple, K. Tansley.

Recent Studies of Lighting and Vision, R. G. Hopkinson.

Twin Research in Ophthalmology, P. J. Waardenburg.

Ophthalmic Aspects of Protein Deficiency and Disordered Protein Metabolism, G. B. Bietti.

Some Aspects of Ocular Pharmacology, A. J. Schaeffer.

Protective Glasses for Welding, G. A. W. Rutgers.

Modern Refinements in Tonometry, J. S. Friedenwald and R. Moses.

BOOKS RECEIVED

Reviews of the following will appear in *Ophthalmic Literature.*

Clinical Orthoptic Procedure. By W. SMITH. 1950. Pp. 393, 70 illustrations. C. V. Mosby, St. Louis, U.S.A. Kimpton, London. 56*s.*

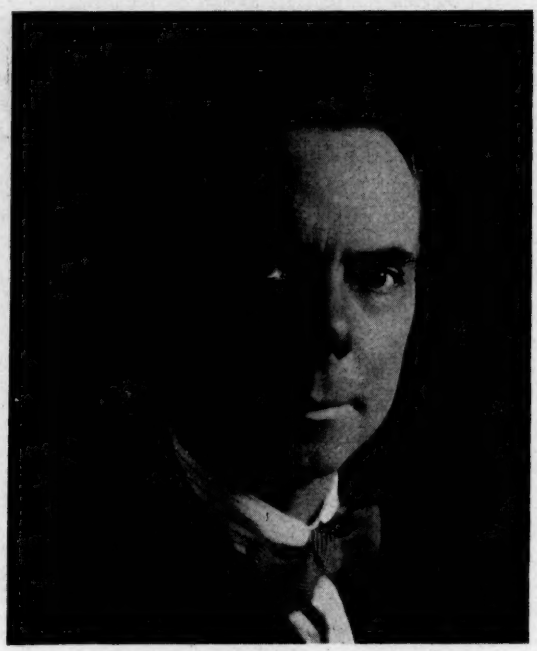
Recent Advances in Ocular Prosthesis. By J. H. PRINCE. 1950. Pp. 155, 89 figs. E. and S. Livingstone, Edinburgh. 20*s.*

A Guide to Ophthalmic Photography and its Application in Teaching. By MARGARET MARKHAM, B.A. 1950. Pp. 128. New York University, Postgraduate Medical School. A mimeographed booklet published as a supplement to the graduate course in Ophthalmology.

OBITUARY

ALEXANDER CHRISTIE REID

ALEXANDER CHRISTIE REID died in Edinburgh while on holiday on August 20, 1950. Born in 1877 in Dundee, the son of the Rev. Alexander Reid, he was educated at Dundee High School and proceeded to Aberdeen University where he obtained the degrees of M.A. and B.Sc. in 1897. Turning to medicine he graduated M.B. (Hons.) in 1902, and M.D. (Hons.) in 1905. He took the



ALEXANDER CHRISTIE REID

post of House Surgeon to the West Norfolk and King's Lynn Hospital, and afterwards went into general practice, first in Rotherham, where he became interested in coal-miners' nystagmus, and then in Nottingham. He was appointed Honorary Assistant Surgeon to the Nottingham and Midland Eye Infirmary in 1909, and full Honorary Surgeon in 1919, having meanwhile obtained the Diploma in Ophthalmology of Oxford in 1913, He was also Honorary Ophthalmic Surgeon to the Mansfield and Worksop Hospitals, and

Adviser in Ophthalmology to the Kesteven County Council. Reid served in the R.A.M.C. in the great war, when he was mentioned in despatches; he retired from practice in 1947. His publications include "Miners' Nystagmus" (*Brain*, 1906, **29**, 363), "On Nystagmus" (*Ophthalmic Review*, 1908, **27**, 165), and "The Problem of the Hypermetropic Miner" (*British Journal of Ophthalmology*, 1943, **27**, 110).

A keen church worker and for many years an Elder of his church and Session Clerk, he originally hoped to become a medical missionary but was rejected on medical grounds. He was known to his colleagues as a man of the highest integrity, who carried out his work with thoroughness and efficiency; his handwriting showed the neatness and good discipline of an orderly mind; he was never ruffled by circumstances and always ready to help and encourage his juniors. In 1911 he married Ellen, eldest daughter of the Rev. J. C. Grant, and to her and to his son and four daughters our deepest sympathy is extended.

MARGARET RANKEN

THE death of Miss Ranken after a short illness was briefly announced in last month's number of the Journal, but it now seems fitting to recall the prominent place which she occupied in ophthalmology. Her work as surgeon-in-charge of the orthoptic department of Sunderland Eye Infirmary has already received high praise. Having successfully organized the training of orthoptists in that institution, she was able to make many constructive suggestions at the Orthoptic Board, whose meetings she regularly attended in London. Her surgical skill in the treatment of squint was enhanced by her familiarity with the physiology of binocular vision.

Miss Ranken was appointed ophthalmic surgeon to the Ingham Infirmary, South Shields, a few years ago, having previously held the post of ophthalmic surgeon to Durham County Hospital. Her early training was varied and thorough. After graduating M.B. from the University of Durham in 1924, she did more than 20 years' work at the Victoria Infirmary, Newcastle-upon-Tyne, as house surgeon, refractionist, registrar, and associate surgeon.

Ophthalmology was far from being Miss Ranken's sole interest. She found time to play an active part in the Medical Women's Federation, and was formerly president of the Sunderland branch of the Soroptimists. She will be remembered not only for her professional achievements, but also because she was a pleasant companion on visits to other clinics, a loyal colleague, and a surgeon whose patience and gentleness of touch made children readily entrust themselves to her care.

NOTES

LECTURES

UNIVERSITY of Glasgow, Department of Ophthalmology, Autumn Term, 1950. During October a series of four meetings was held in the Department on Wednesdays at 8 p.m. The general arrangements were similar to those of last year. A discussion followed the main paper.

October 4, Dr. Fergus Campbell, "Experimental Corneal Lesions"; October 11, Professor W. J. B. Riddell, "Clinical Investigations with Aureomycin"; October 18, Dr. Stewart Renfrew, "Extra-foveal Perception of Form"; October 25, Dr. J. M. A. Lenihan, "Biological Action of Radiation".

THE OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM, ANNUAL CONGRESS, 1951

THE Annual Congress of the Ophthalmological Society will be held at the Royal Society of Medicine, 1, Wimpole Street, London, W.1., on March 29, 30, and 31, 1951. The subject for discussion will be "The Association of Ocular and Articular Disease". The Bowman Lecture will be delivered by Sir Henry Dale, O.M., G.B.E., M.D., F.R.S.

Members may bring guests to the Annual Dinner, which will be held on Thursday, March 29.

Honorary Secretaries: A. G. Cross (Council Business), A. J. B. Goldsmith (Congress Business), 45, Lincoln's Inn Fields, London, W.C.2.

HONOURS

ON the occasion of the 500th Anniversary of St. Salvator's College, the University of St. Andrews conferred the honorary degree of Ll.D. upon Sir Stewart Duke-Elder.